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Wilson et al.

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(54) **SNOWMOBILE**

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(51) **Int. Cl.**

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B62D 55/104	(2006.01)
B62M 27/02	(2006.01)
B60G 7/00	(2006.01)
B60K 15/063	(2006.01)
B62D 1/16	(2006.01)

(52) **U.S. Cl.**

CPC ***B62D 55/30*** (2013.01); ***B60G 7/001*** (2013.01); ***B60K 15/063*** (2013.01); ***B62D 1/16*** (2013.01); ***B62D 55/104*** (2013.01); ***B62M 27/02*** (2013.01); *B62M 2027/026* (2013.01); *B62M 2027/027* (2013.01); *B62M 2027/028* (2013.01)

(58) **Field of Classification Search**

CPC . B62D 55/06; B62M 27/02; B62M 2027/026; B62M 2027/027; B62M 2027/028

USPC 180/190, 191, 193

See application file for complete search history.

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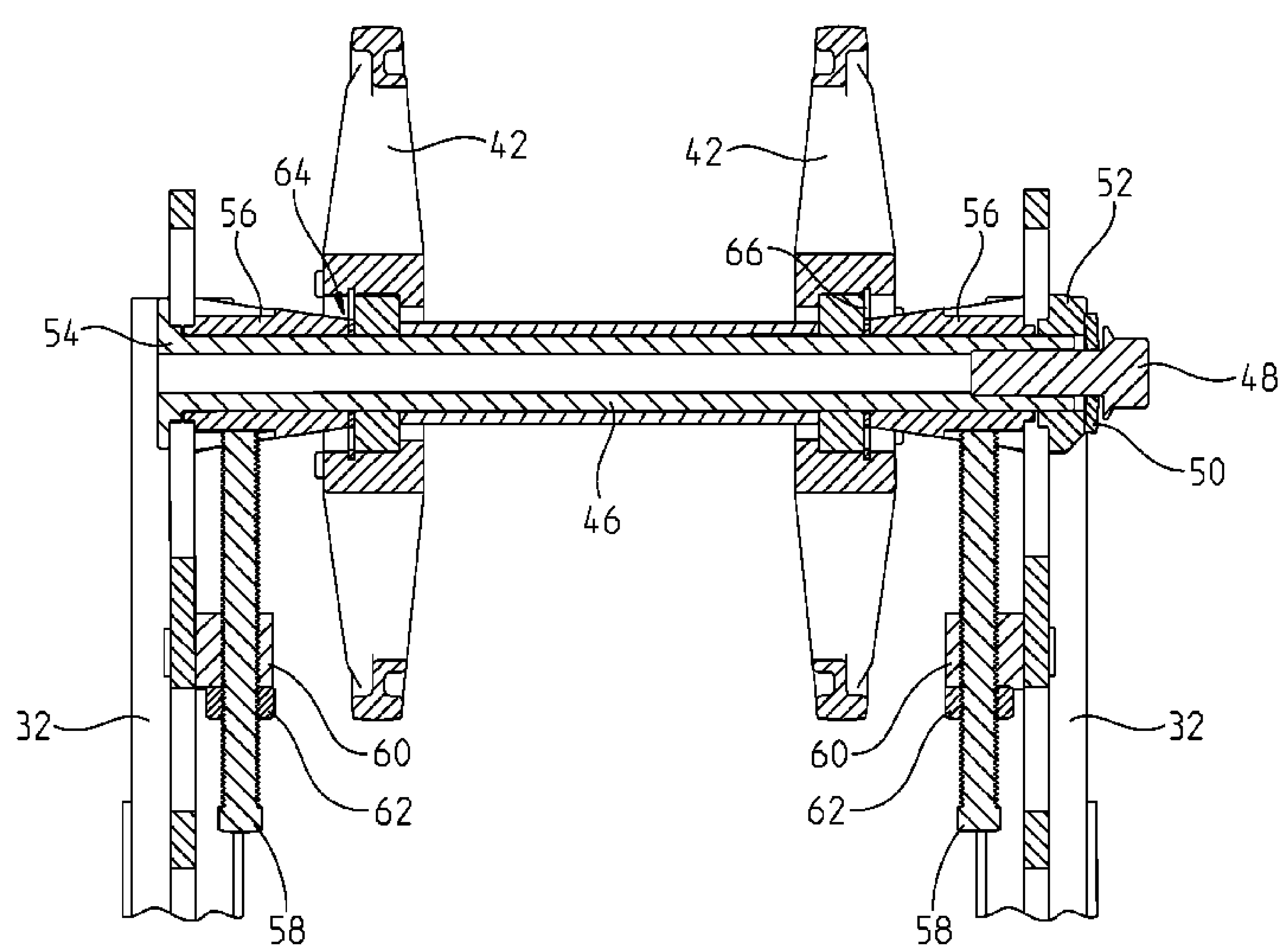
(57) **ABSTRACT**

A snowmobile comprises a plurality of ground engaging members, a frame supported by the ground engaging members, and a powertrain assembly supported by the frame. The snowmobile further comprises a rear suspension assembly supported by the frame which includes a plurality of slide rails, at least one linear force element operably coupled to the slide rails, and at least one rear idler wheel operably coupled to the slide rails with a rear shaft. The rear shaft is operably coupled to the slide rails with a single fastener received into one end of the rear shaft.

16 Claims, 35 Drawing Sheets



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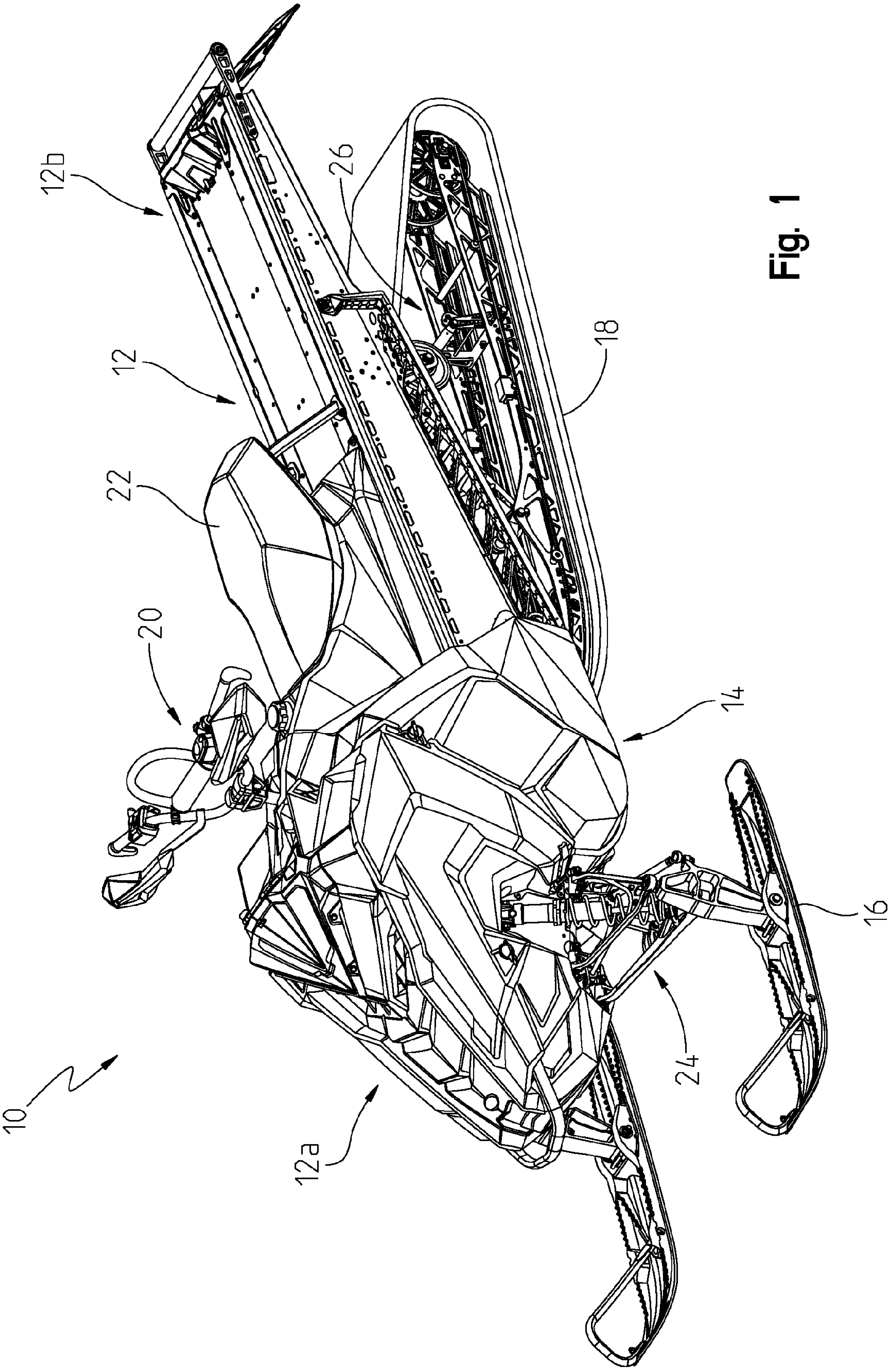


Fig. 1

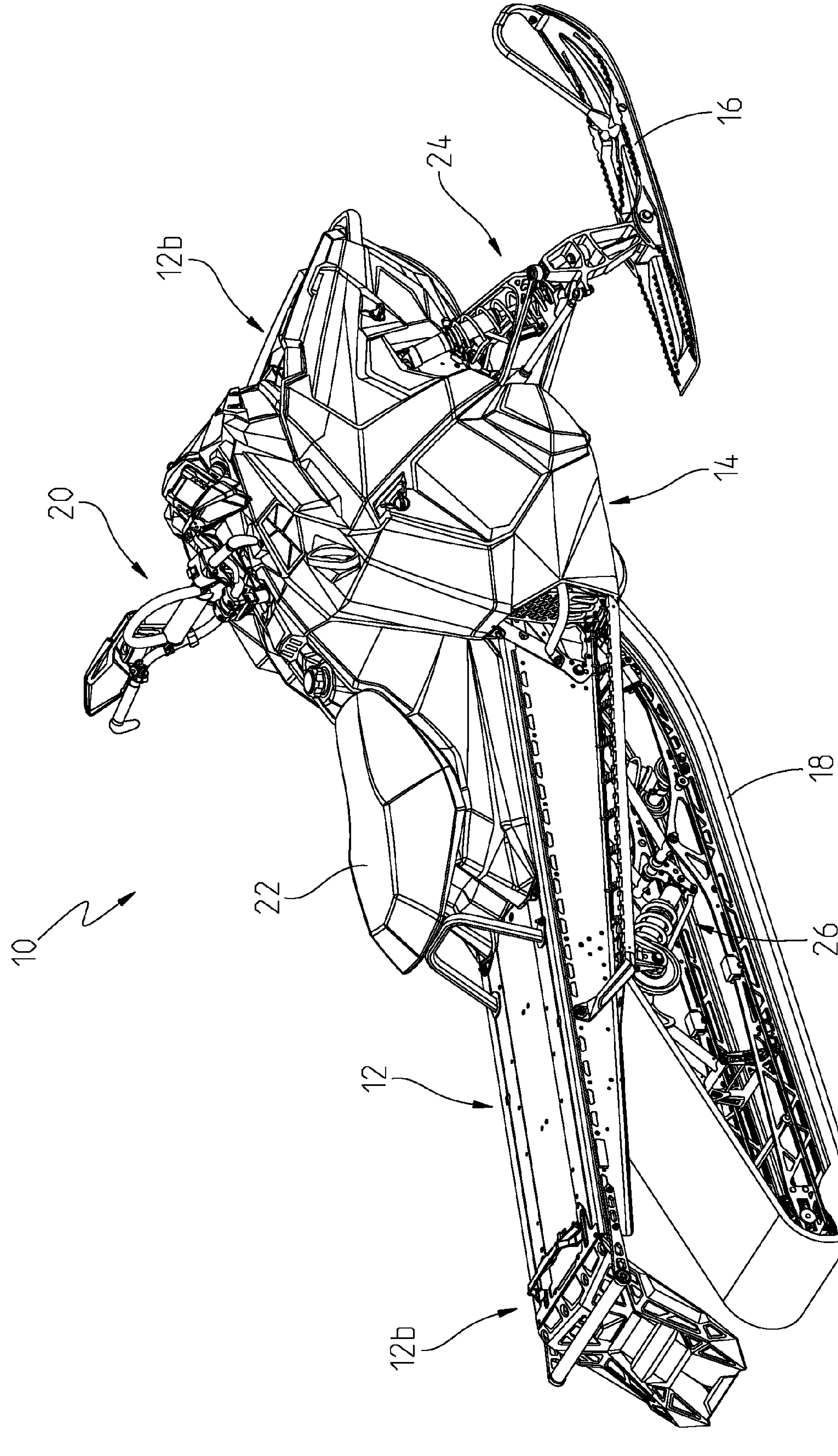
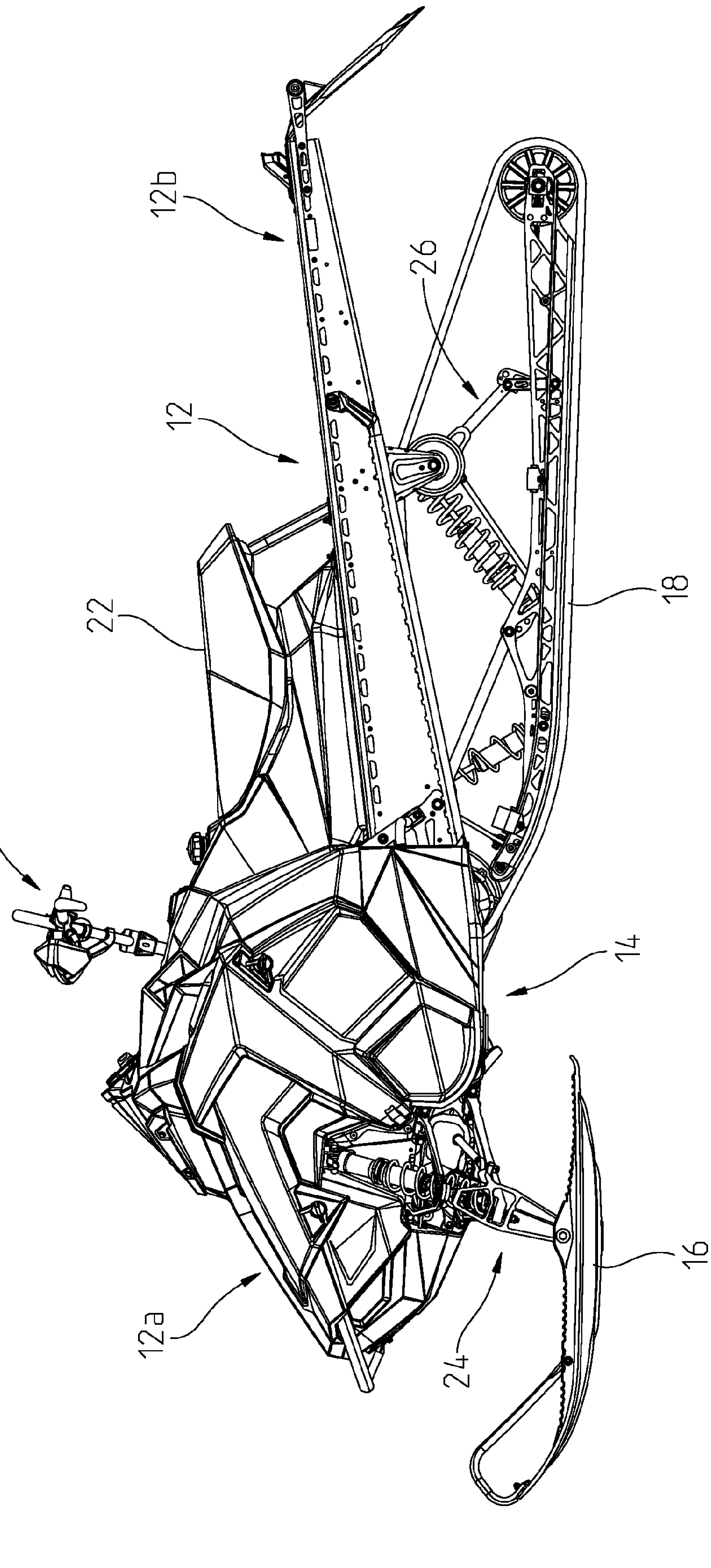


Fig. 2



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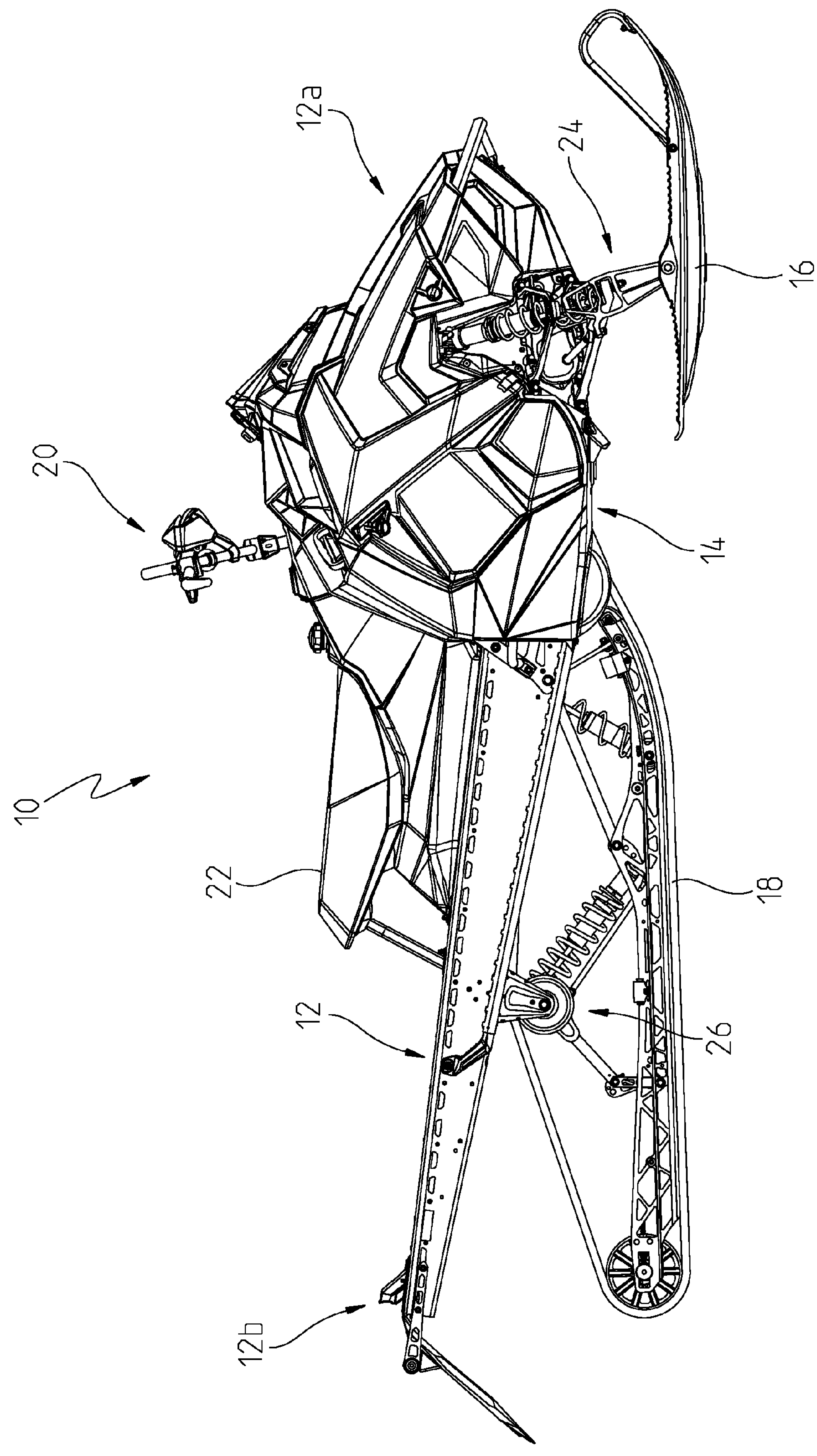
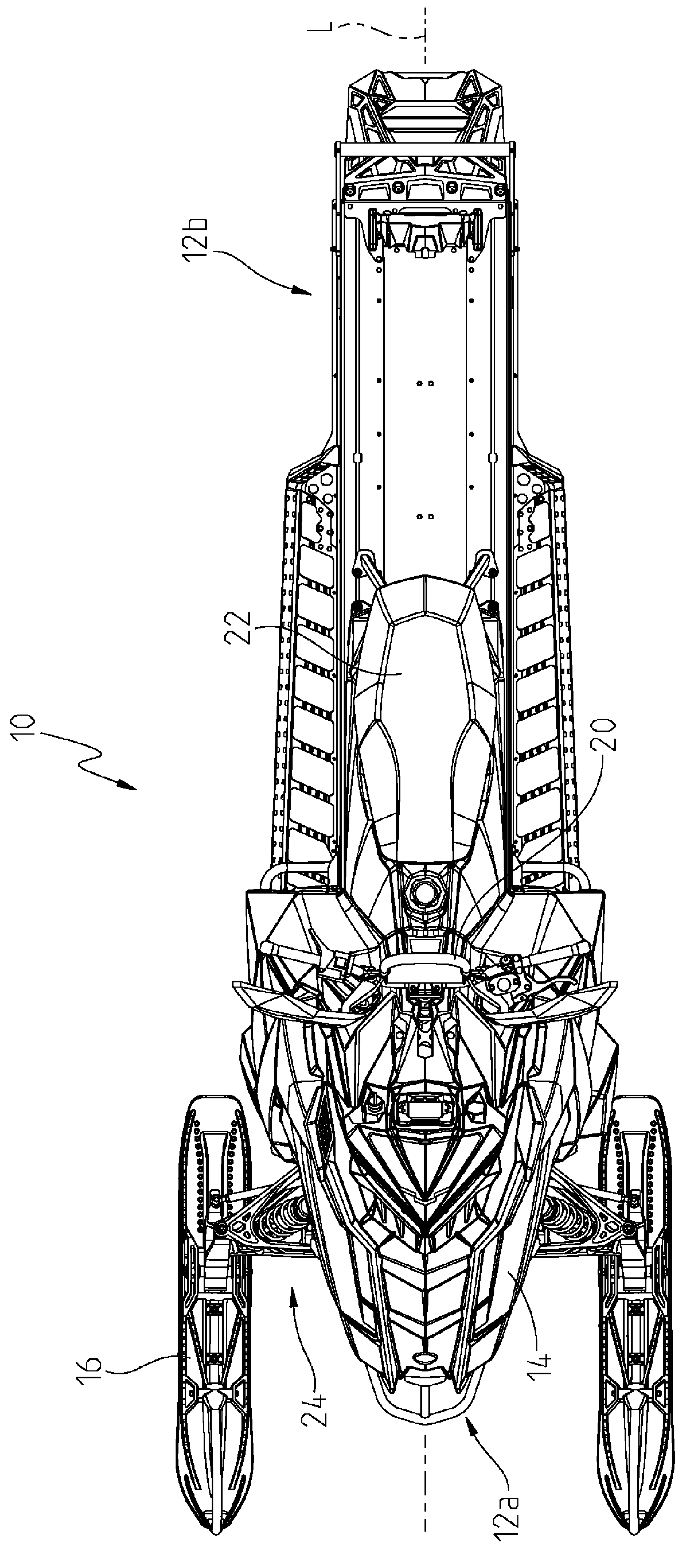


Fig. 4



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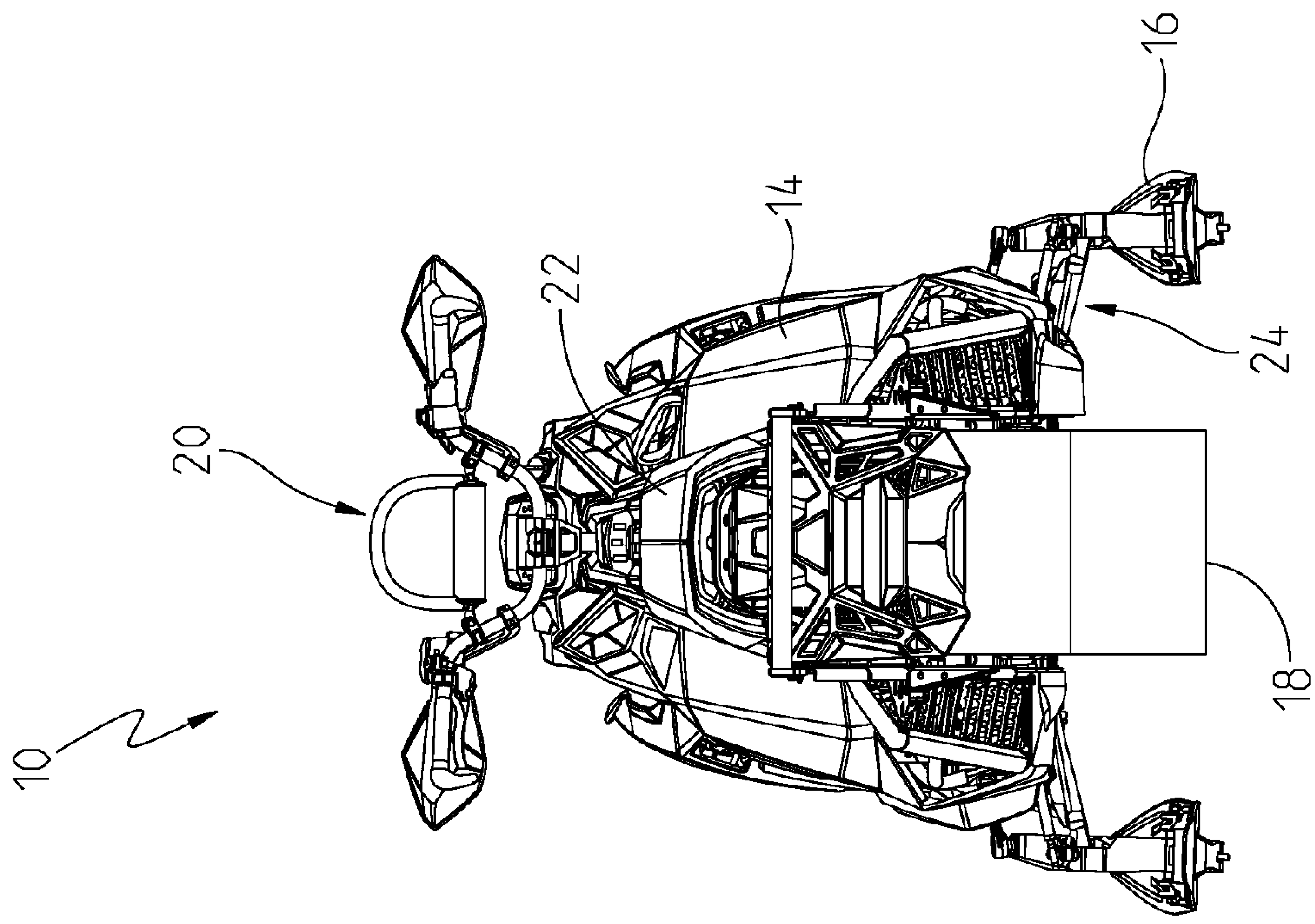

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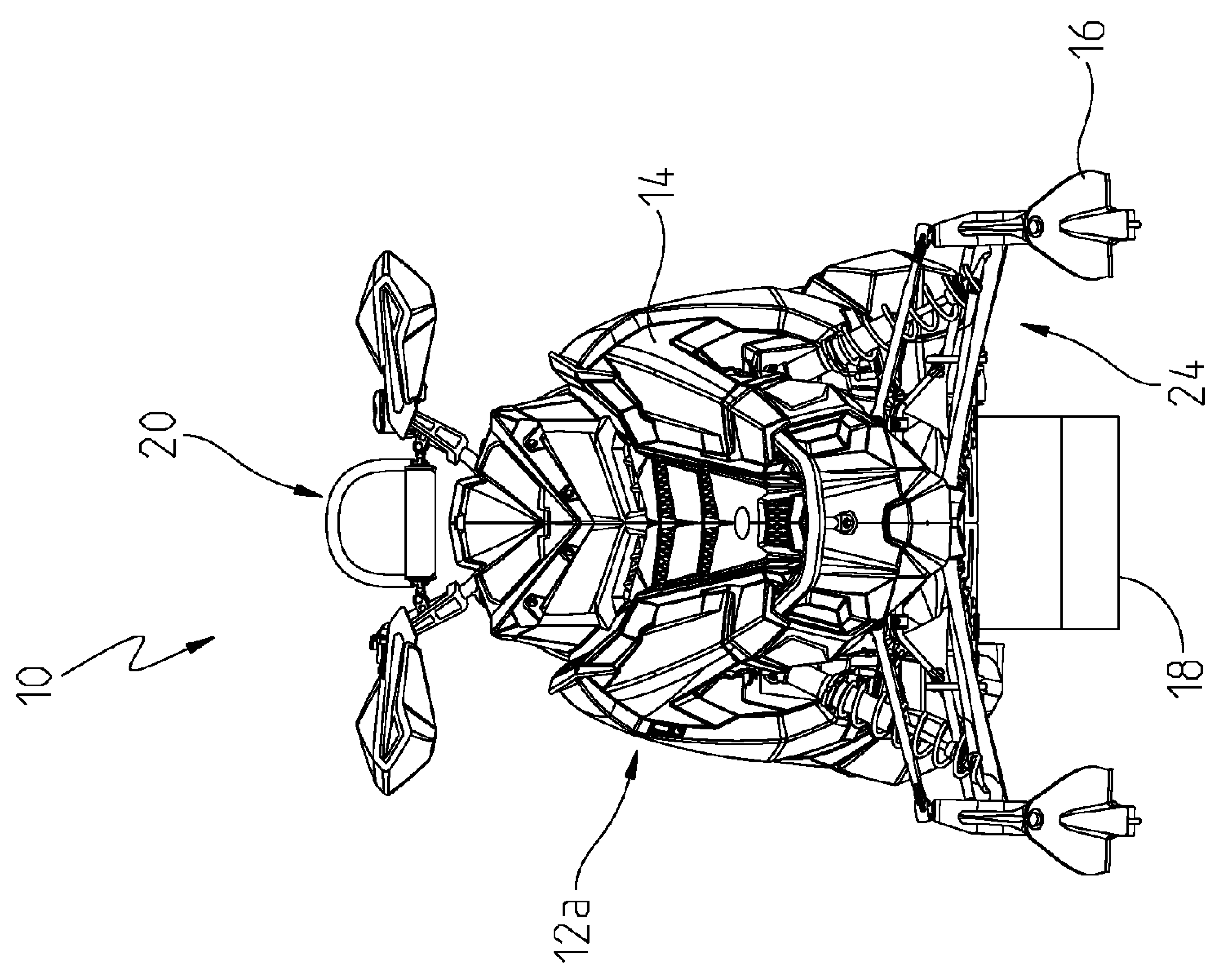

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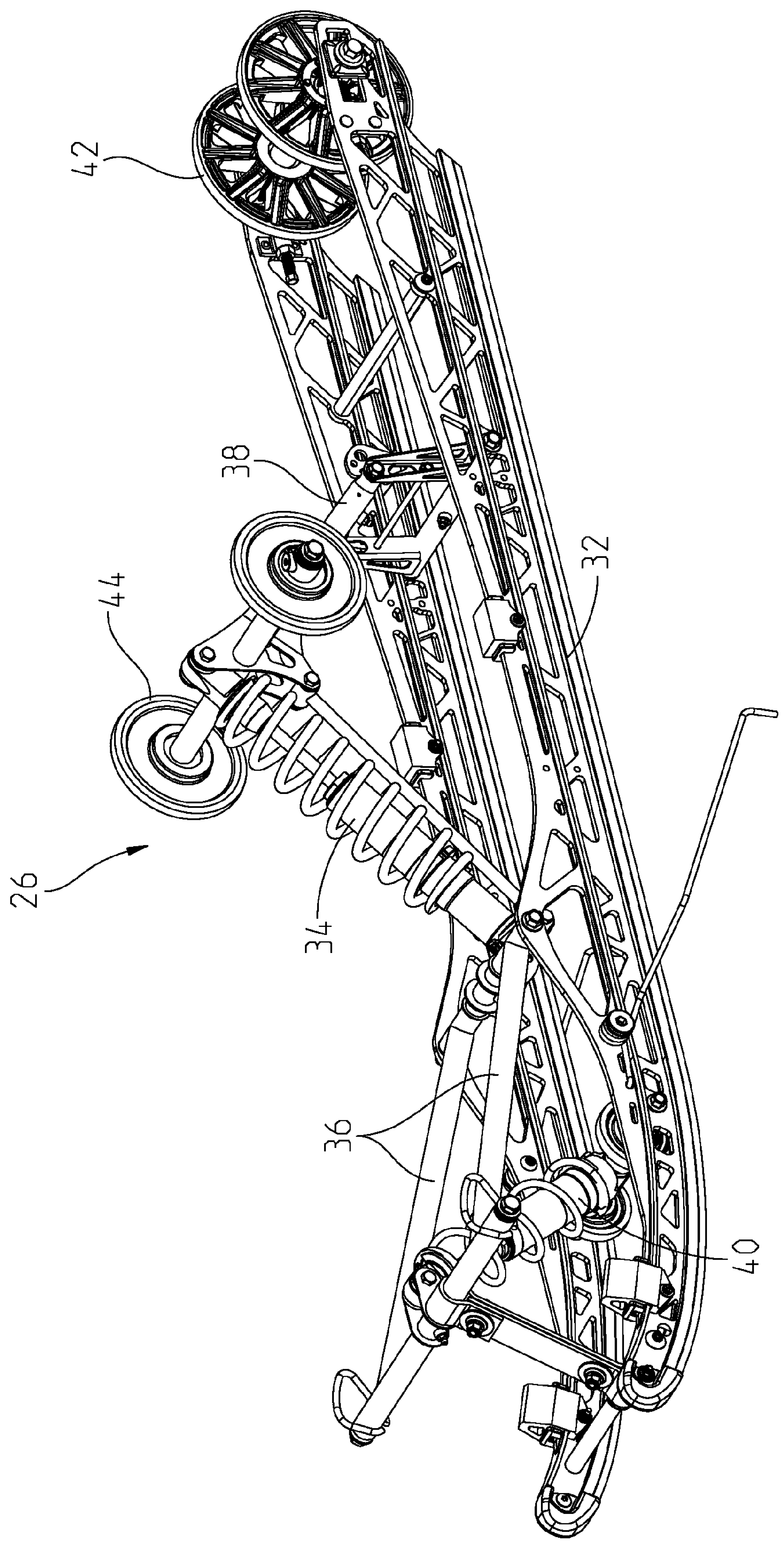

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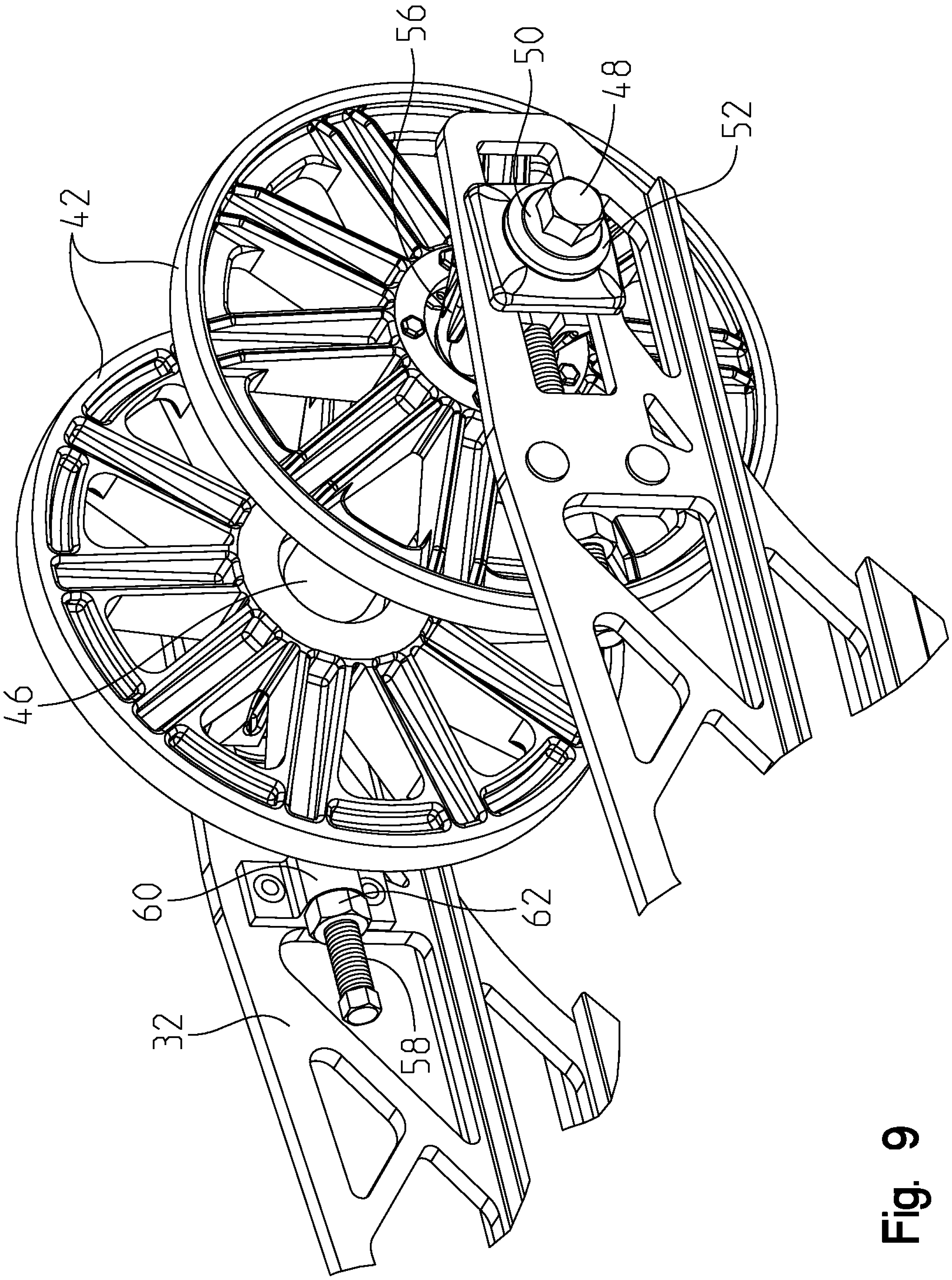

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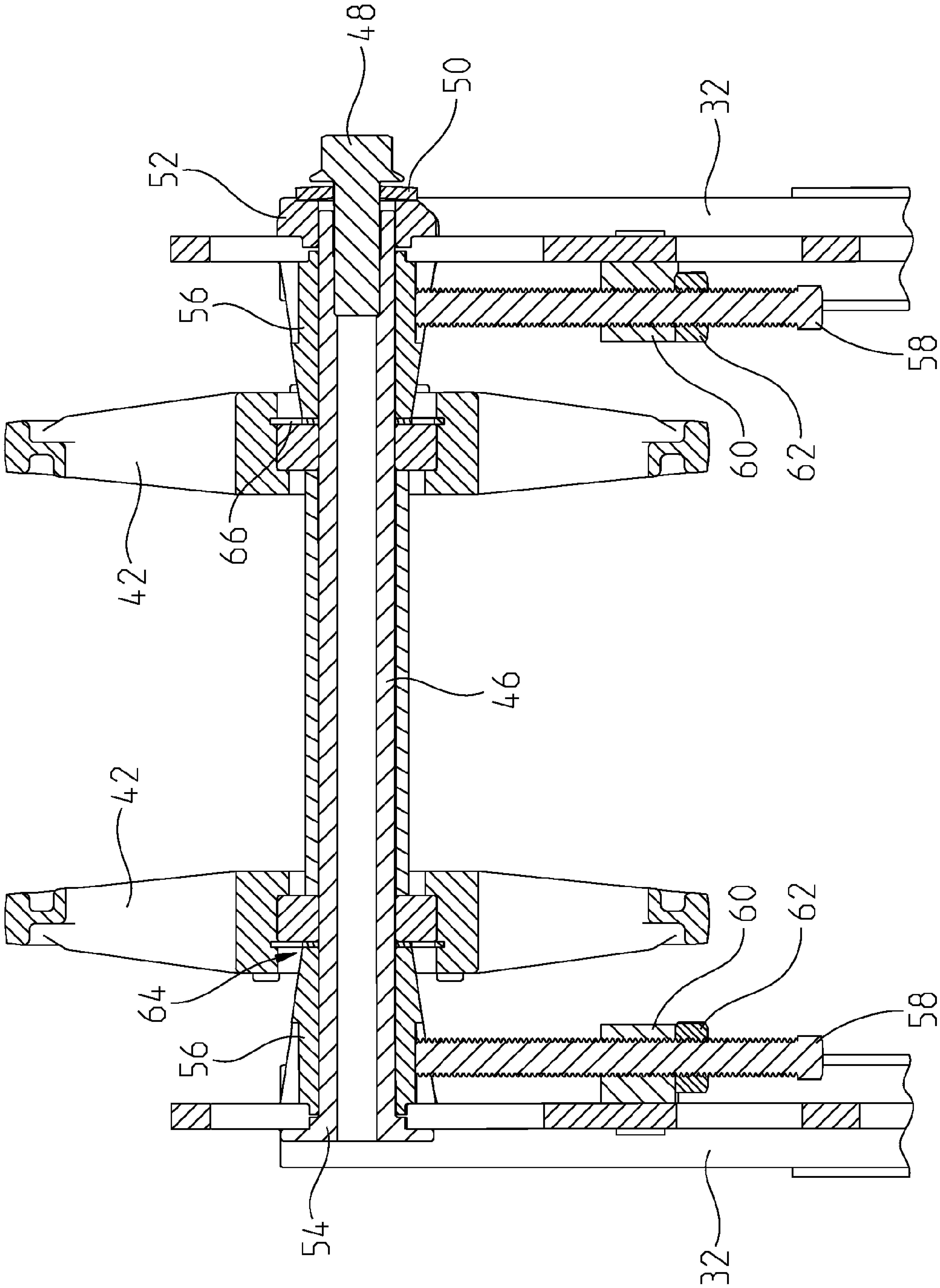

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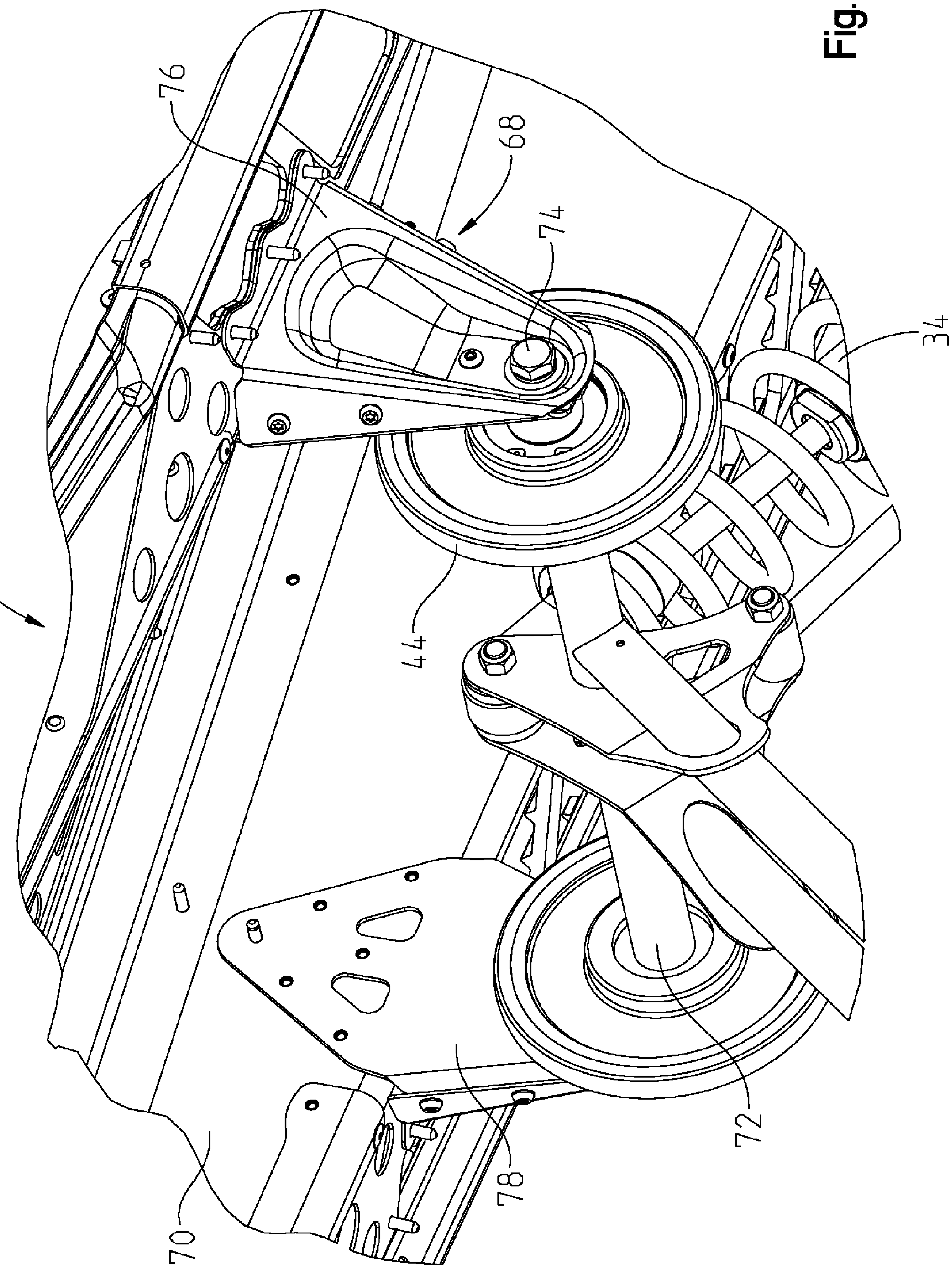

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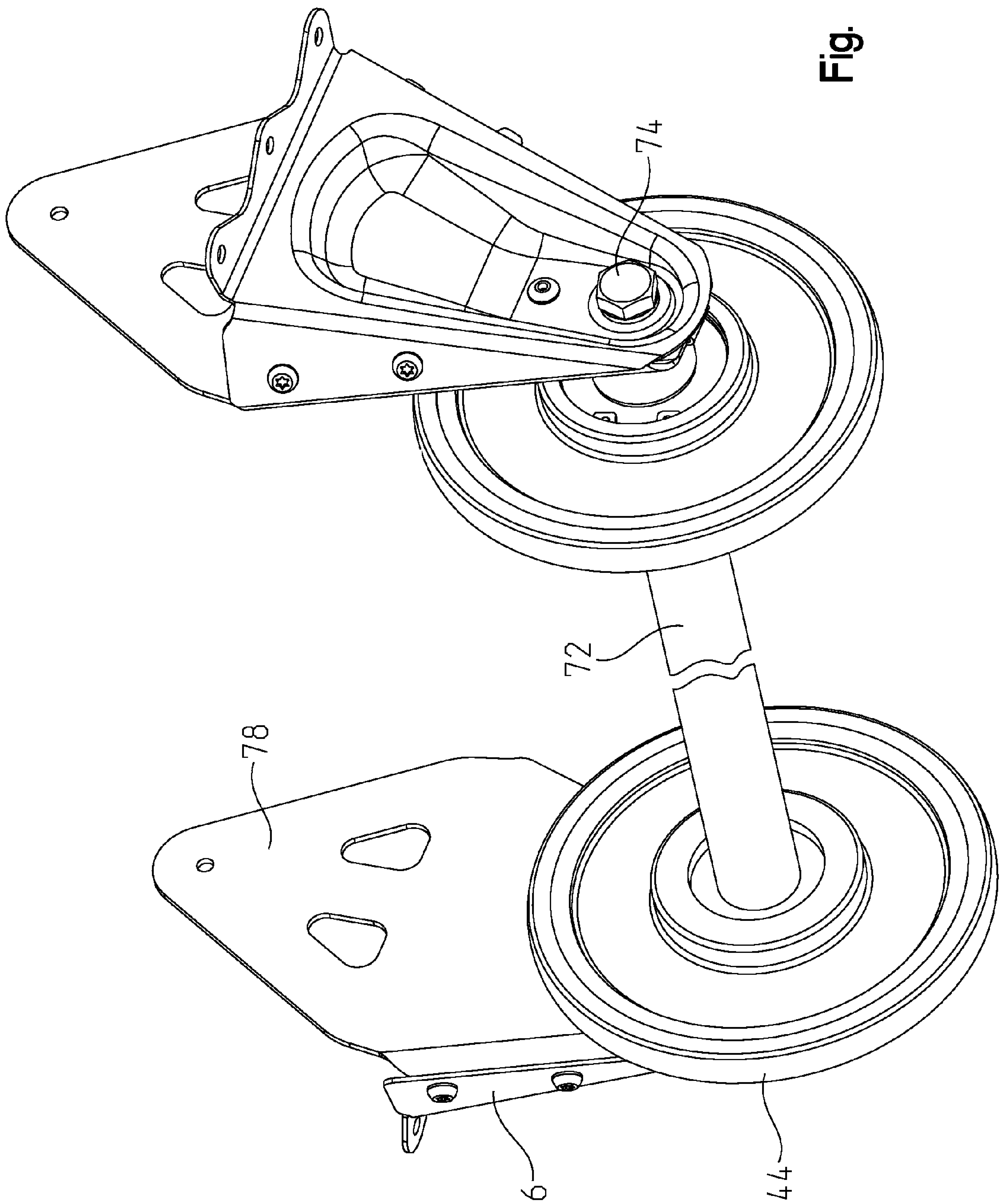

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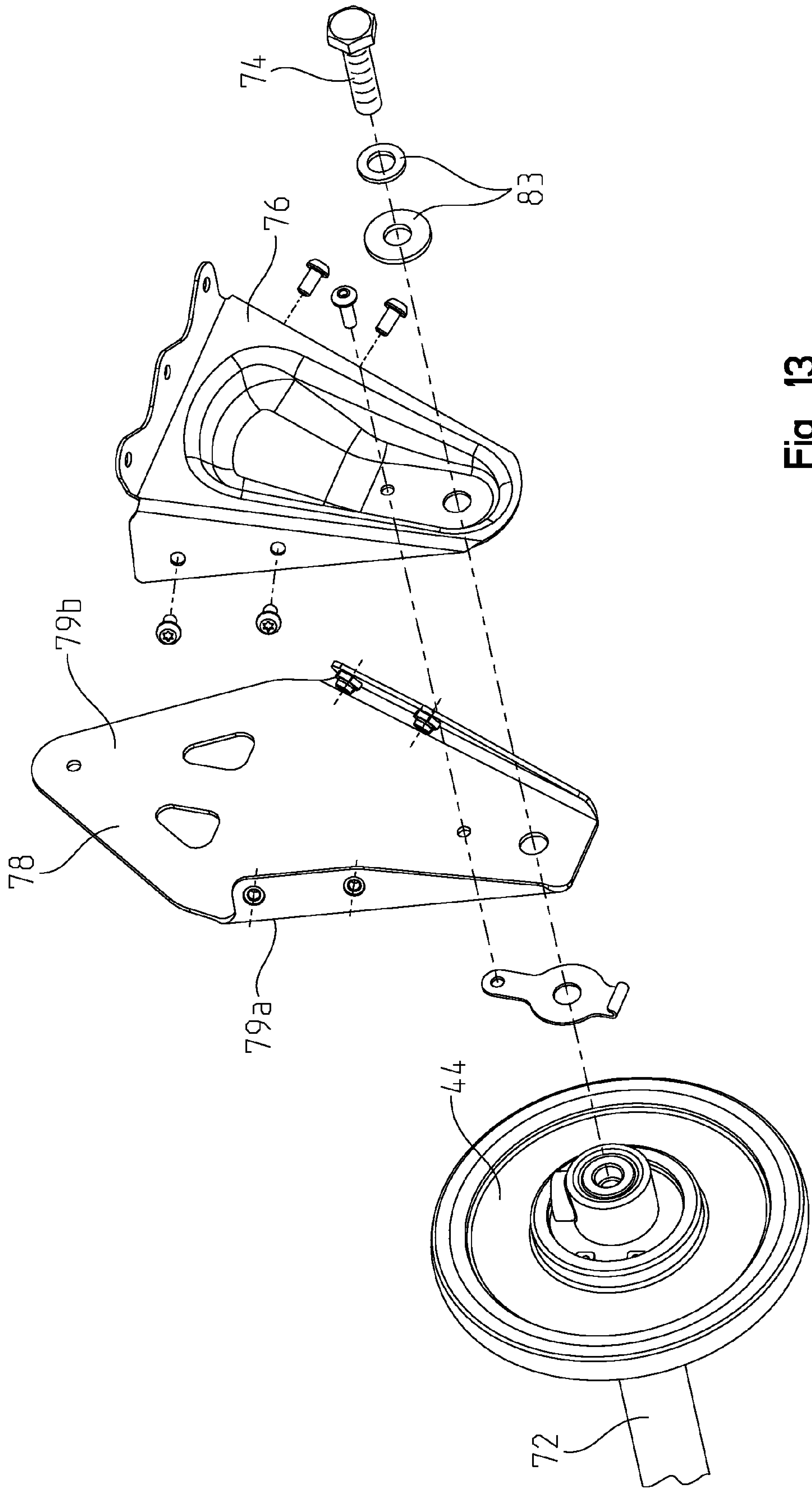

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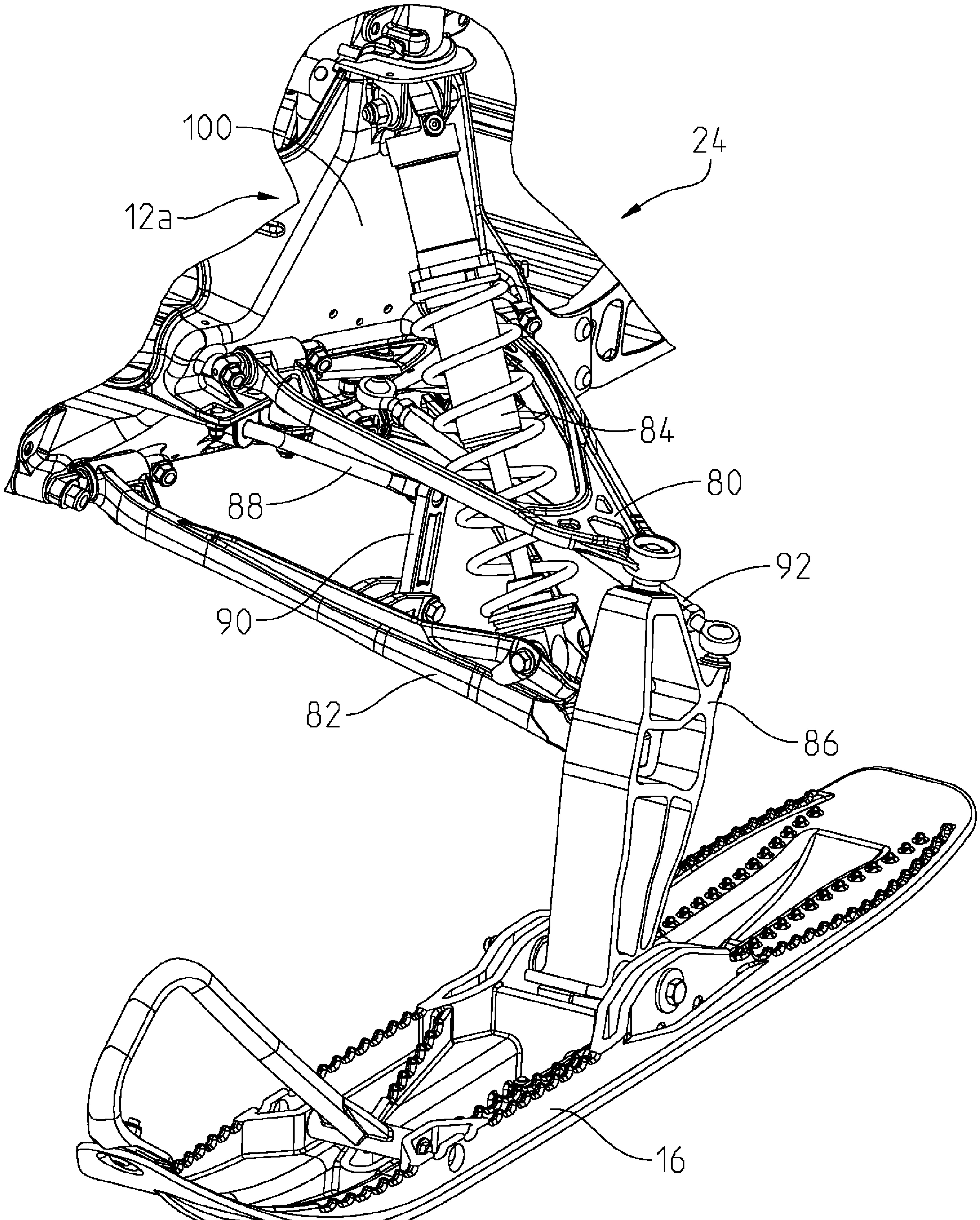

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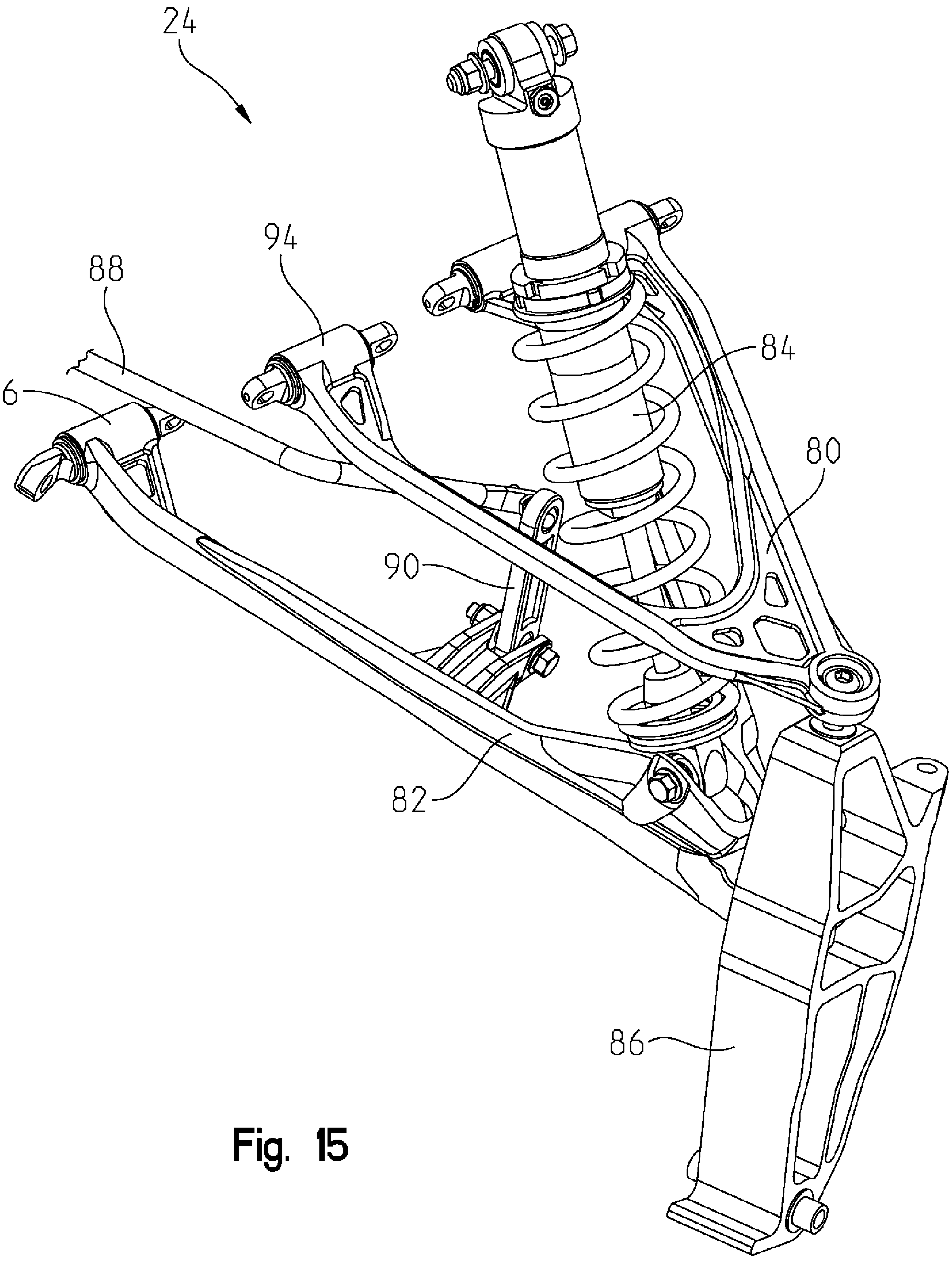

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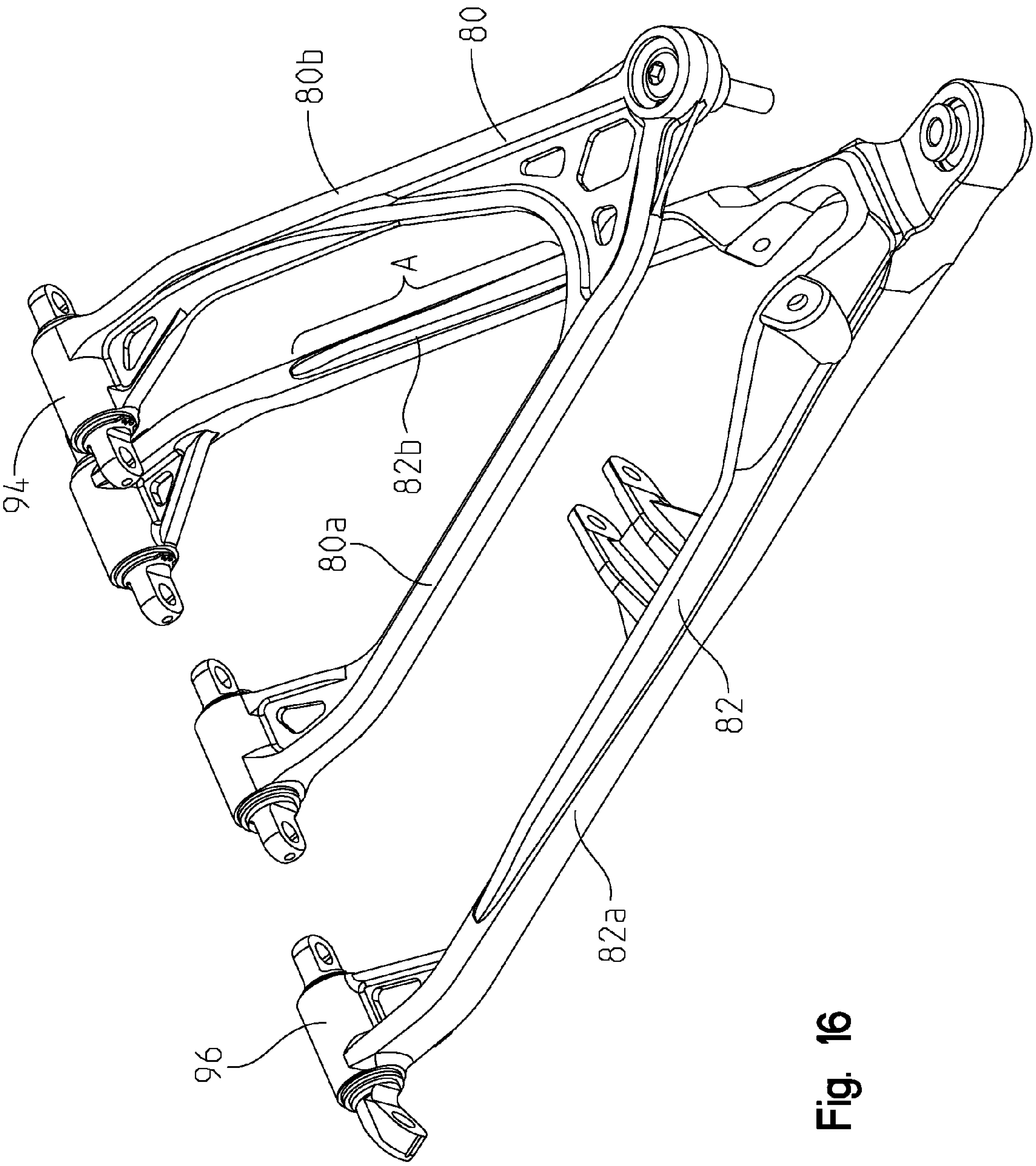

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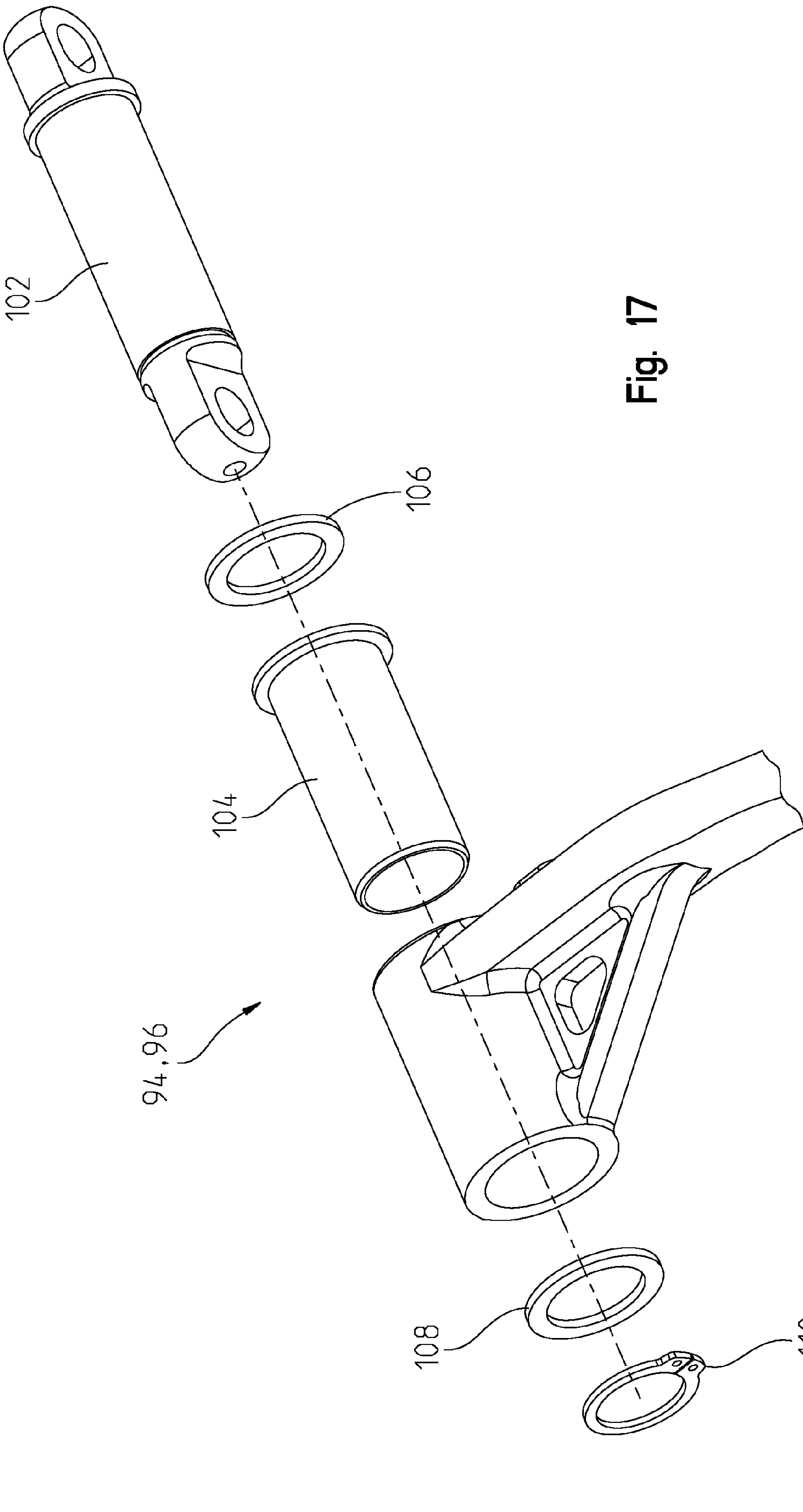

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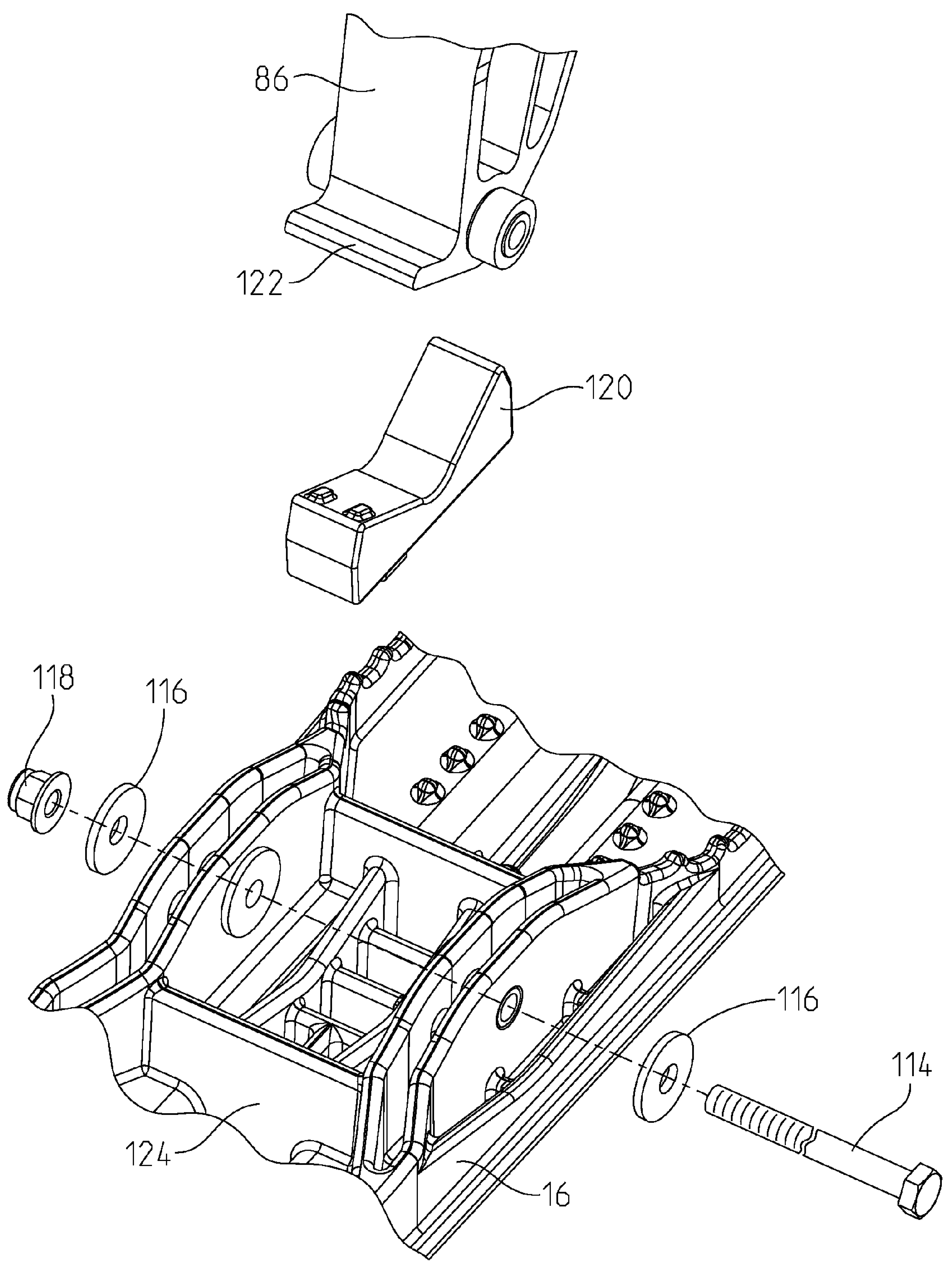
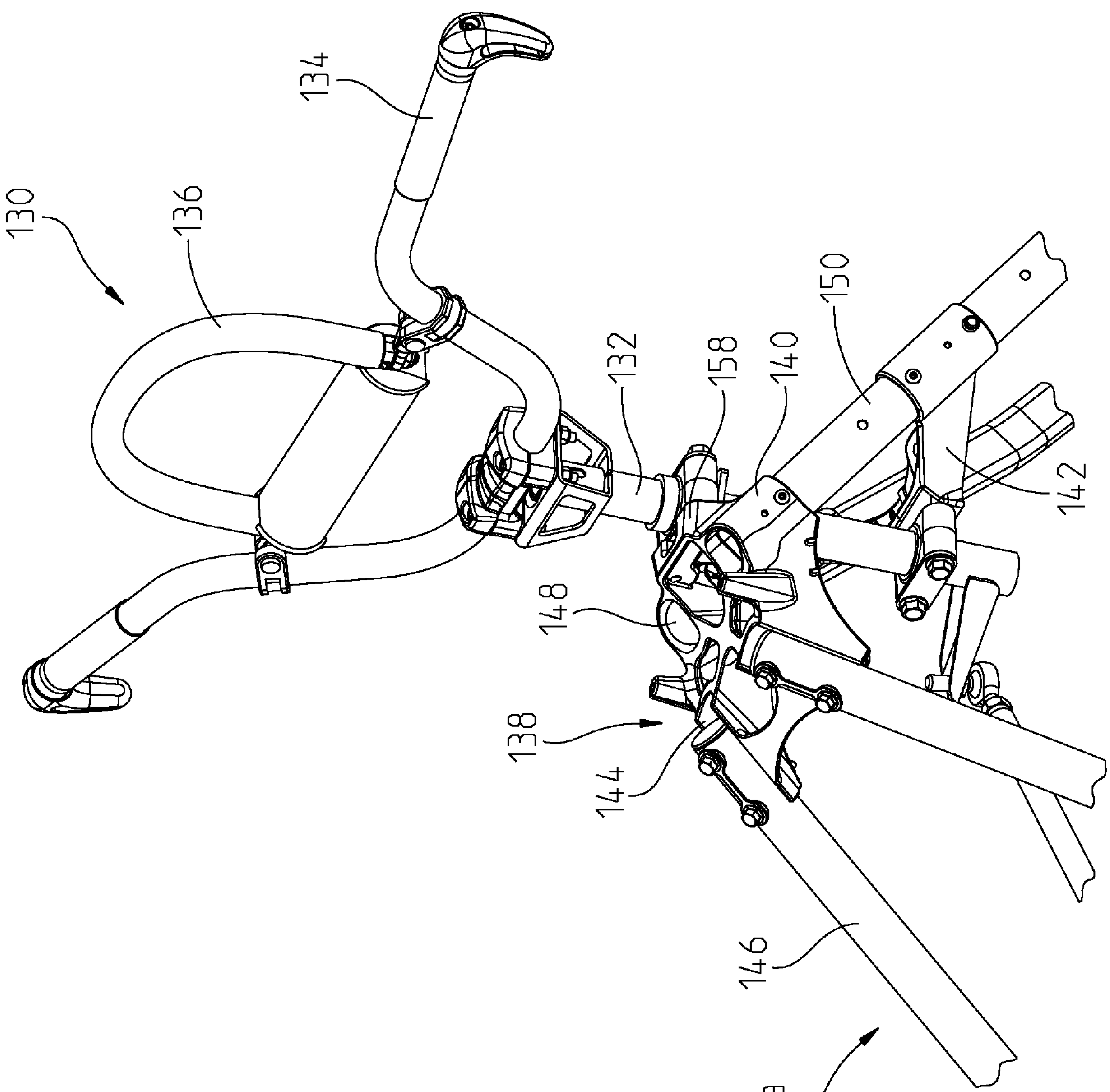
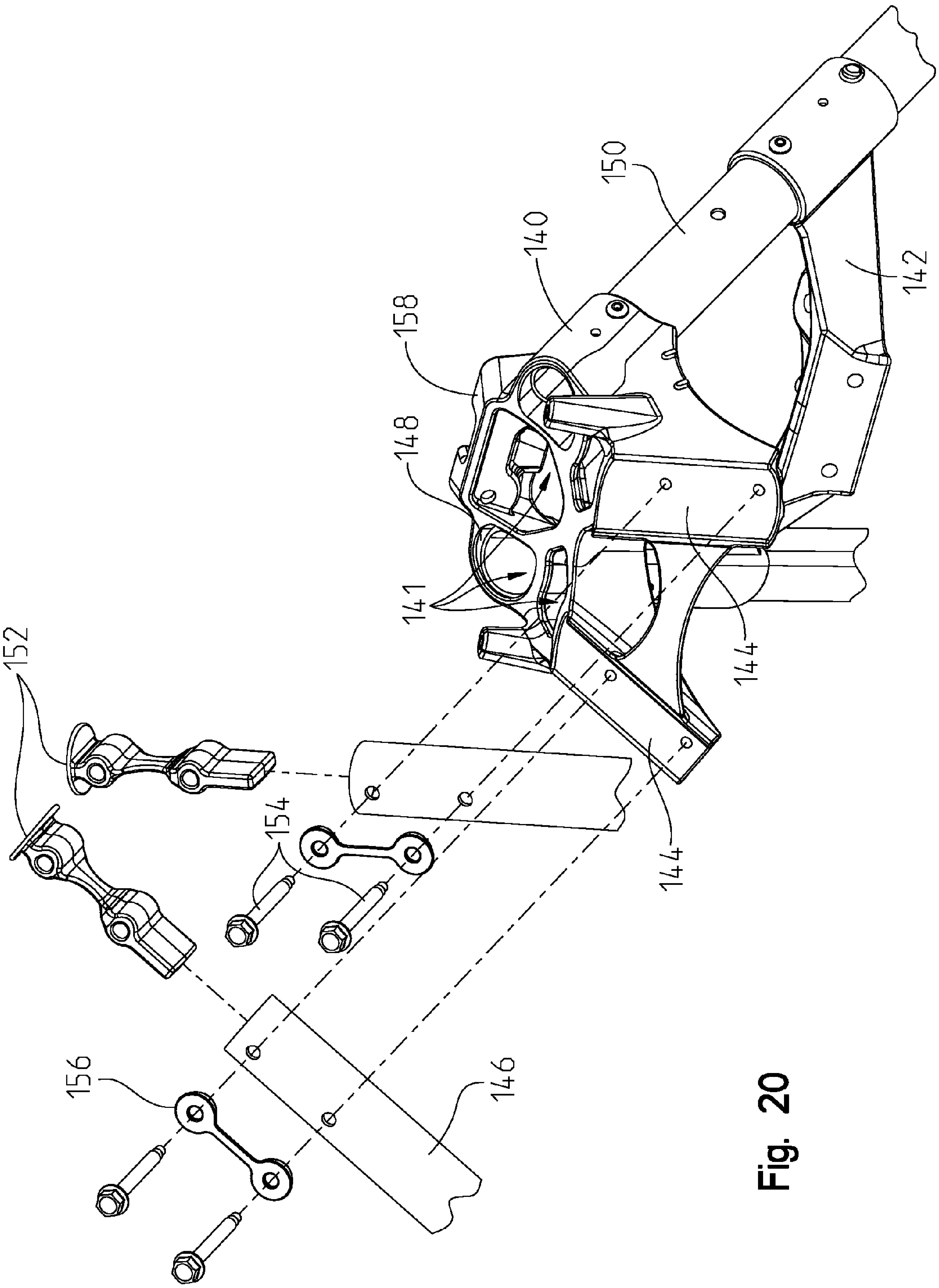


Fig. 18

Fig. 19





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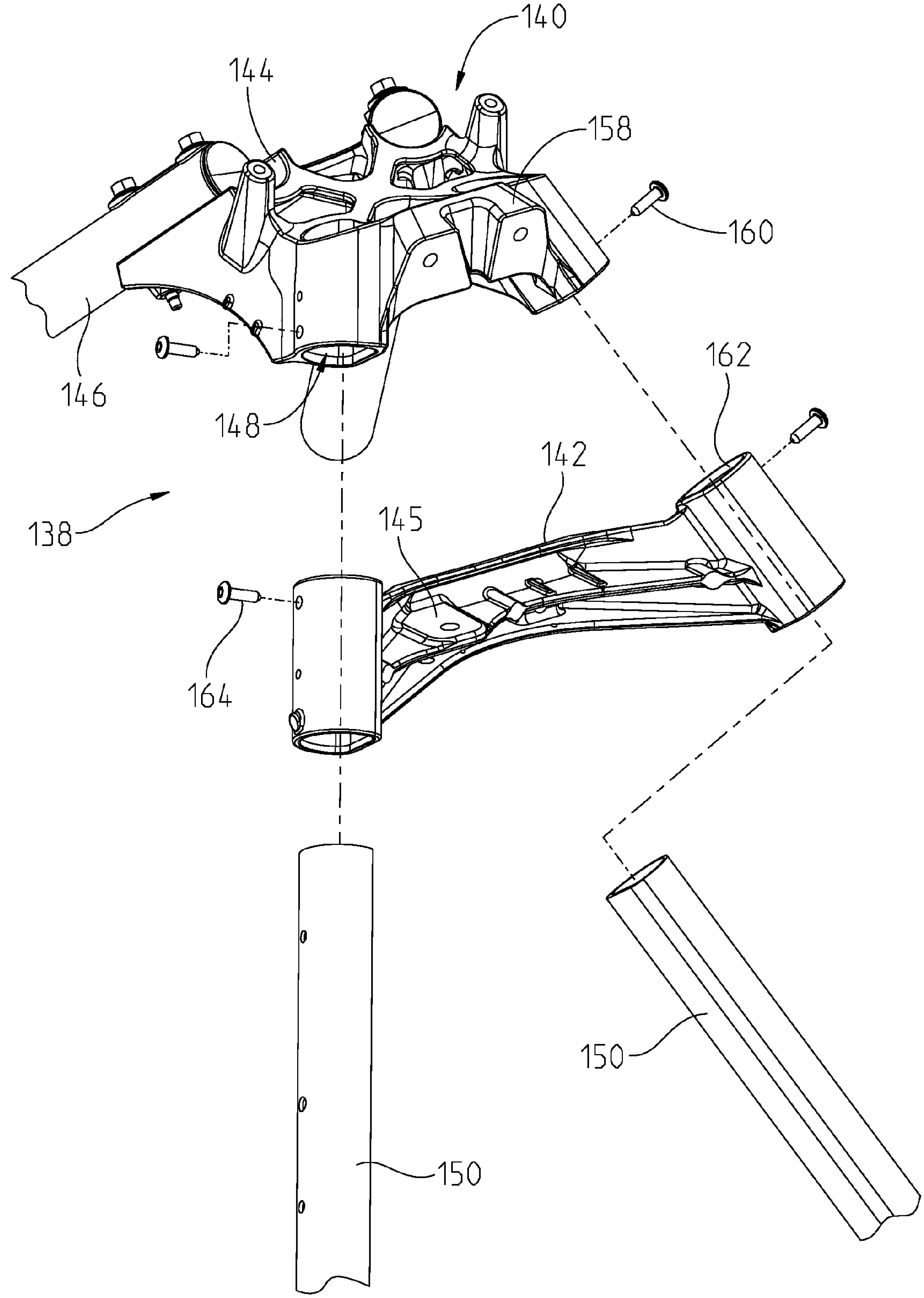

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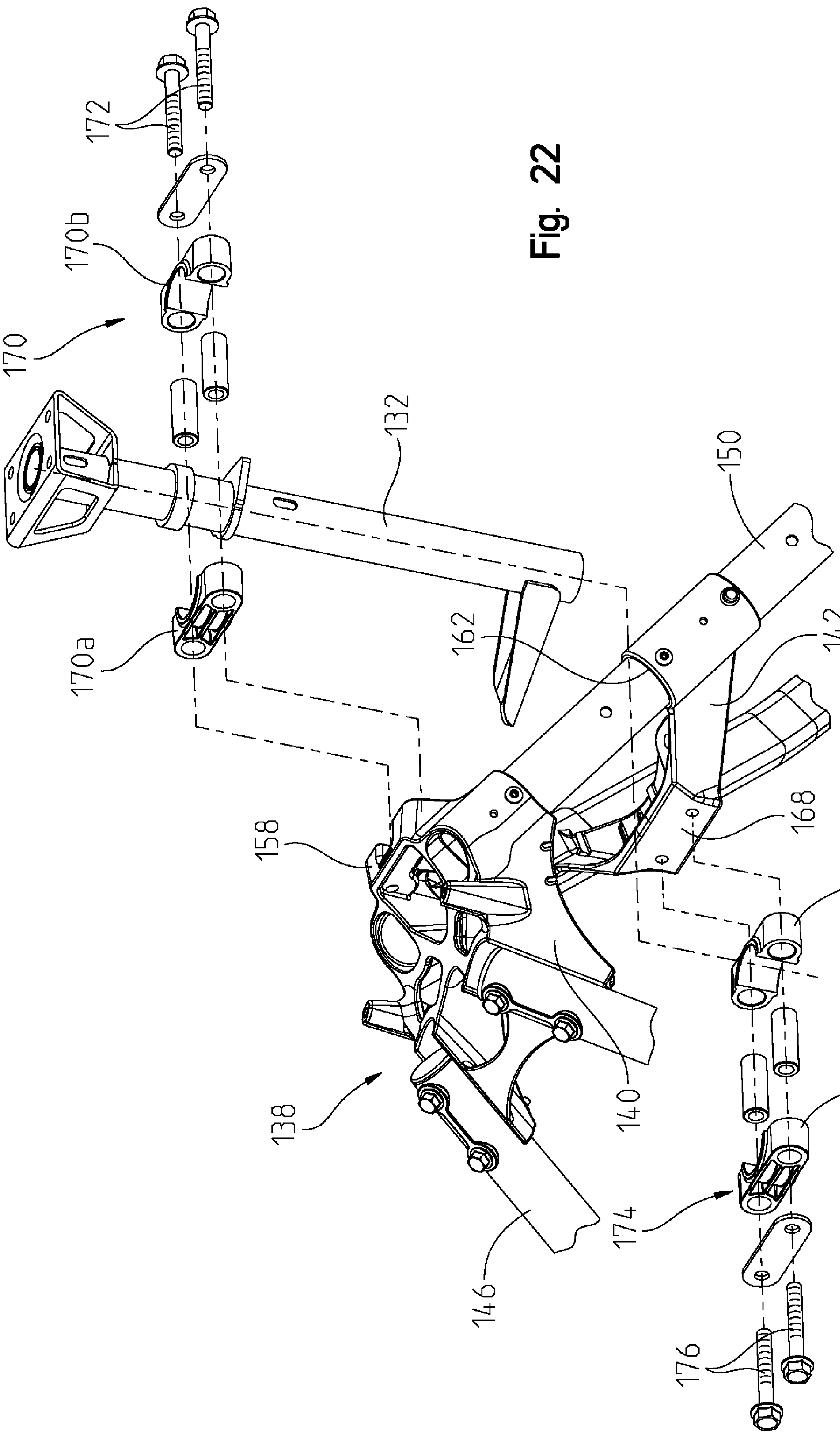
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Fig. 22

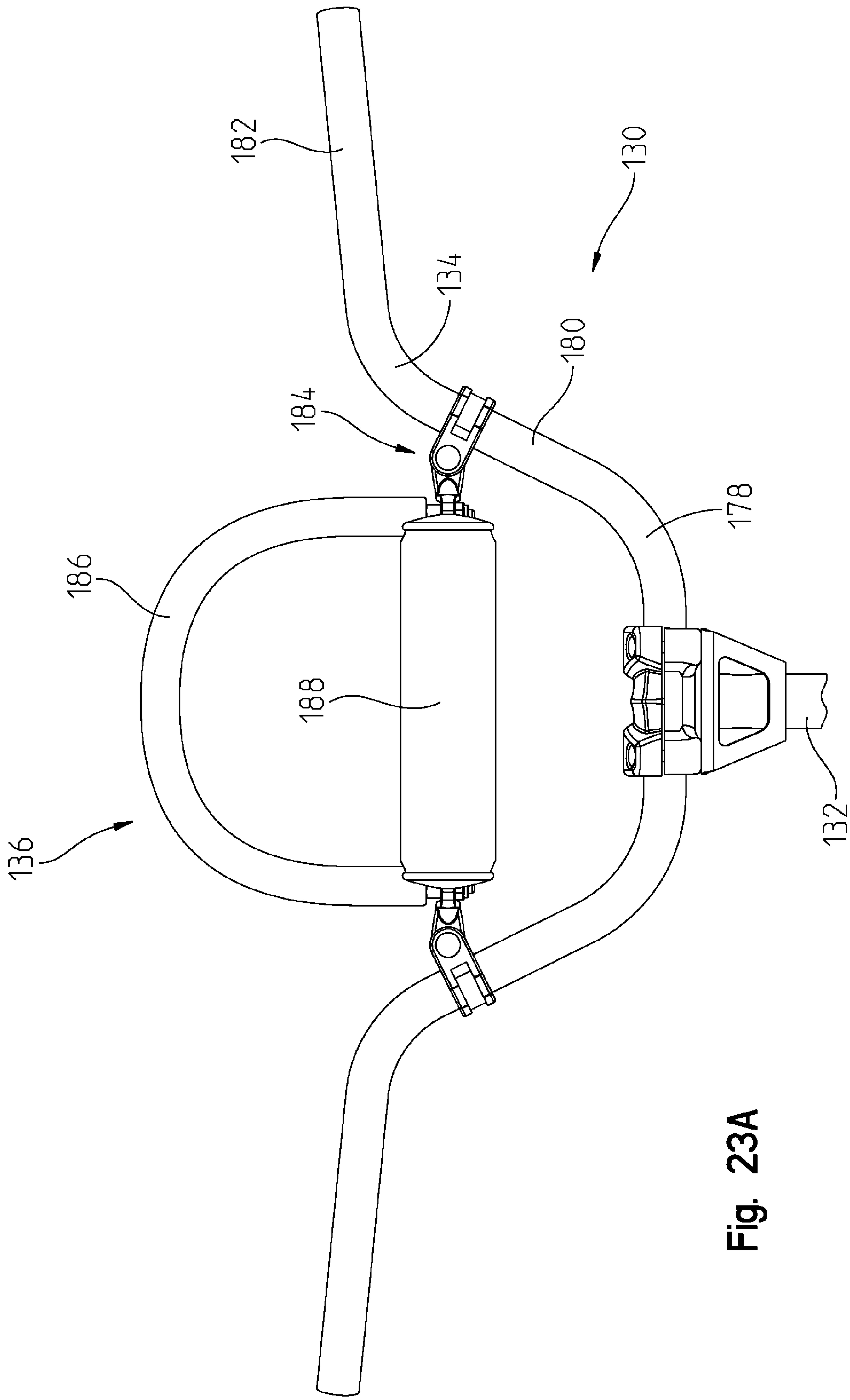

Fig. 23A

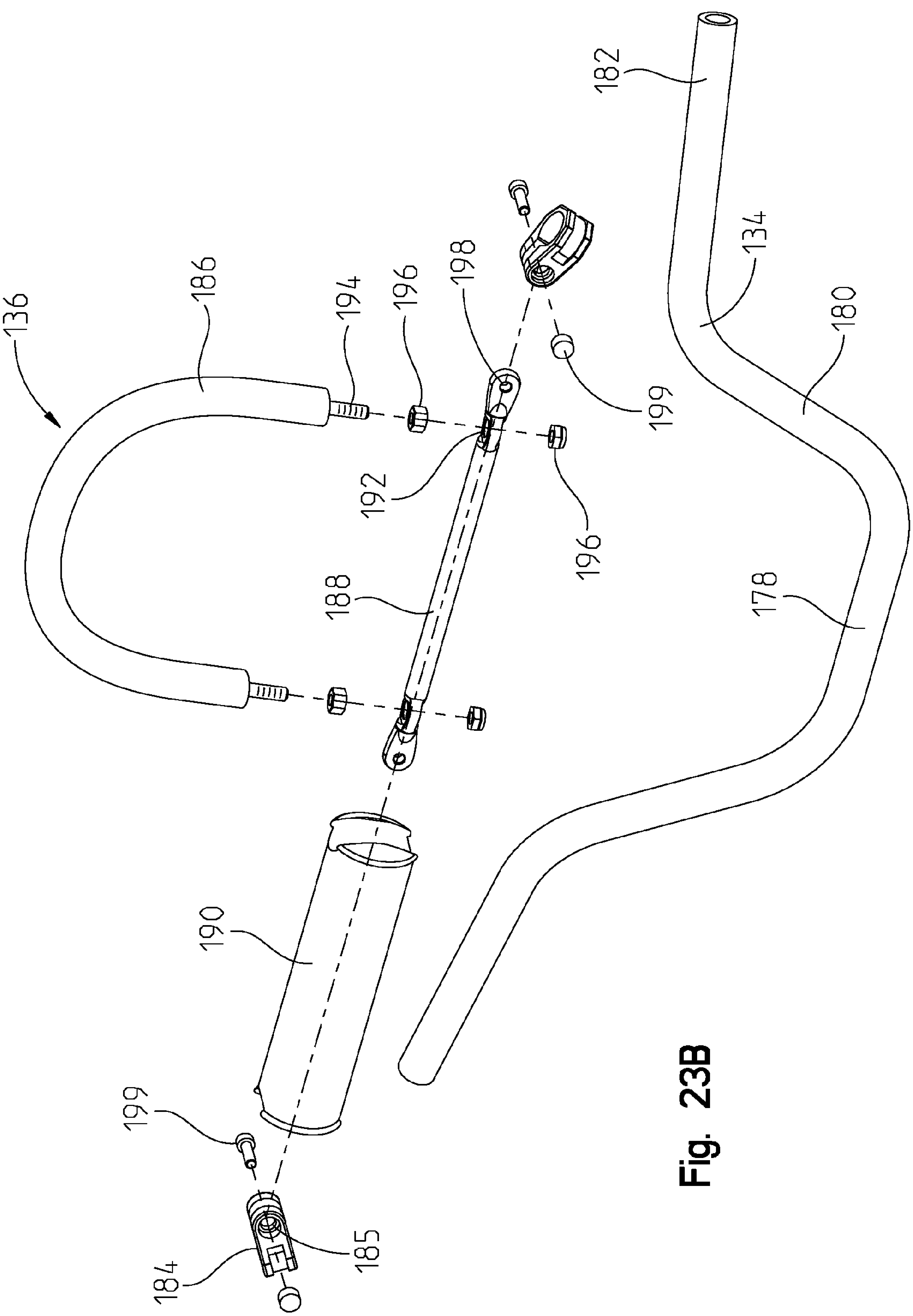

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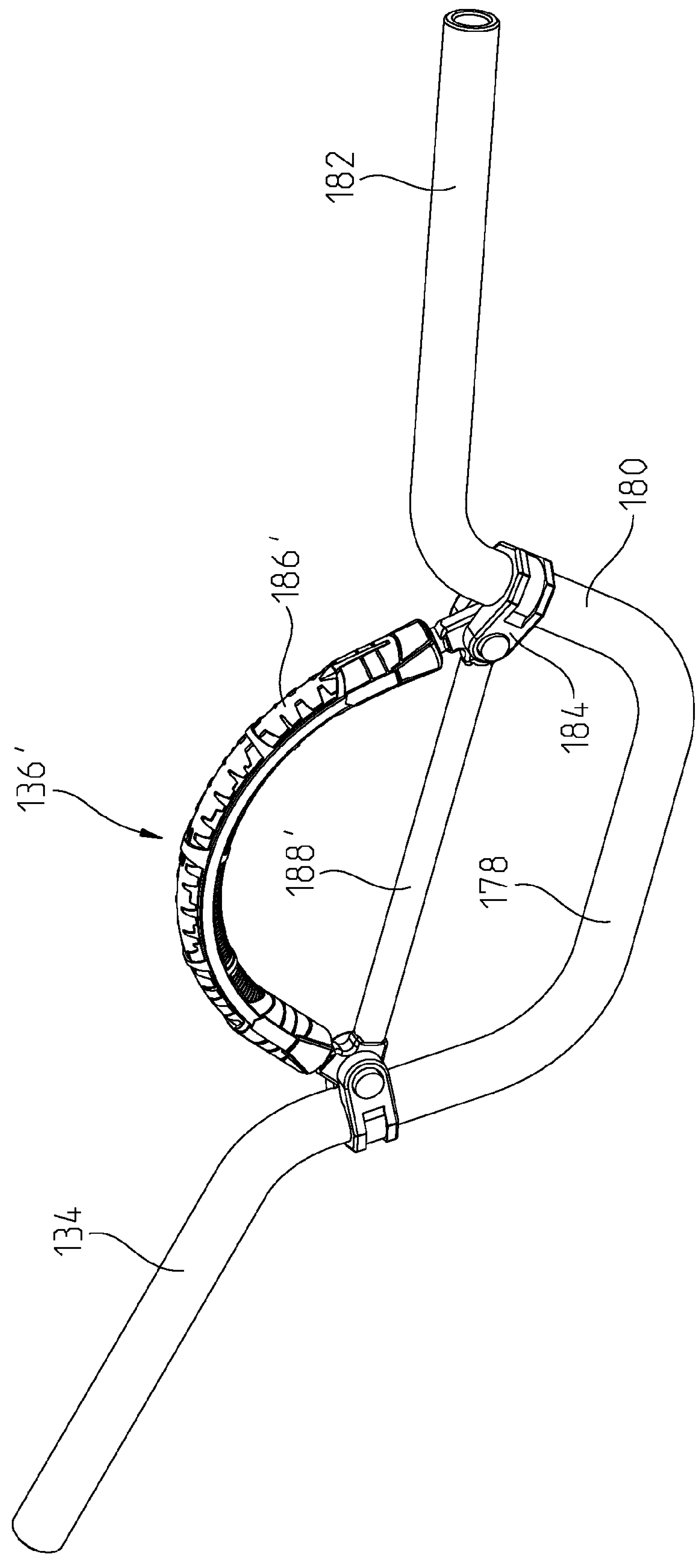
Fig. 23B



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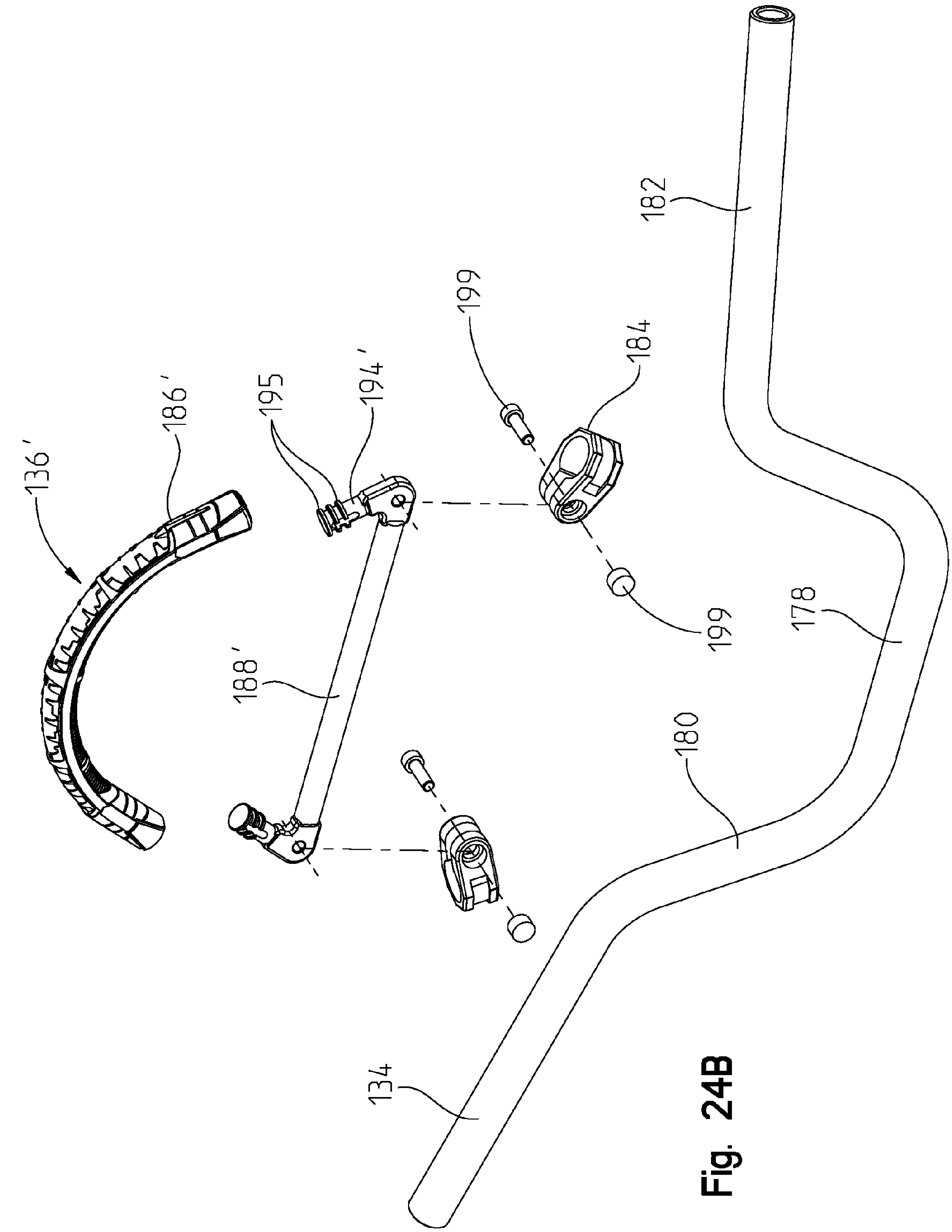

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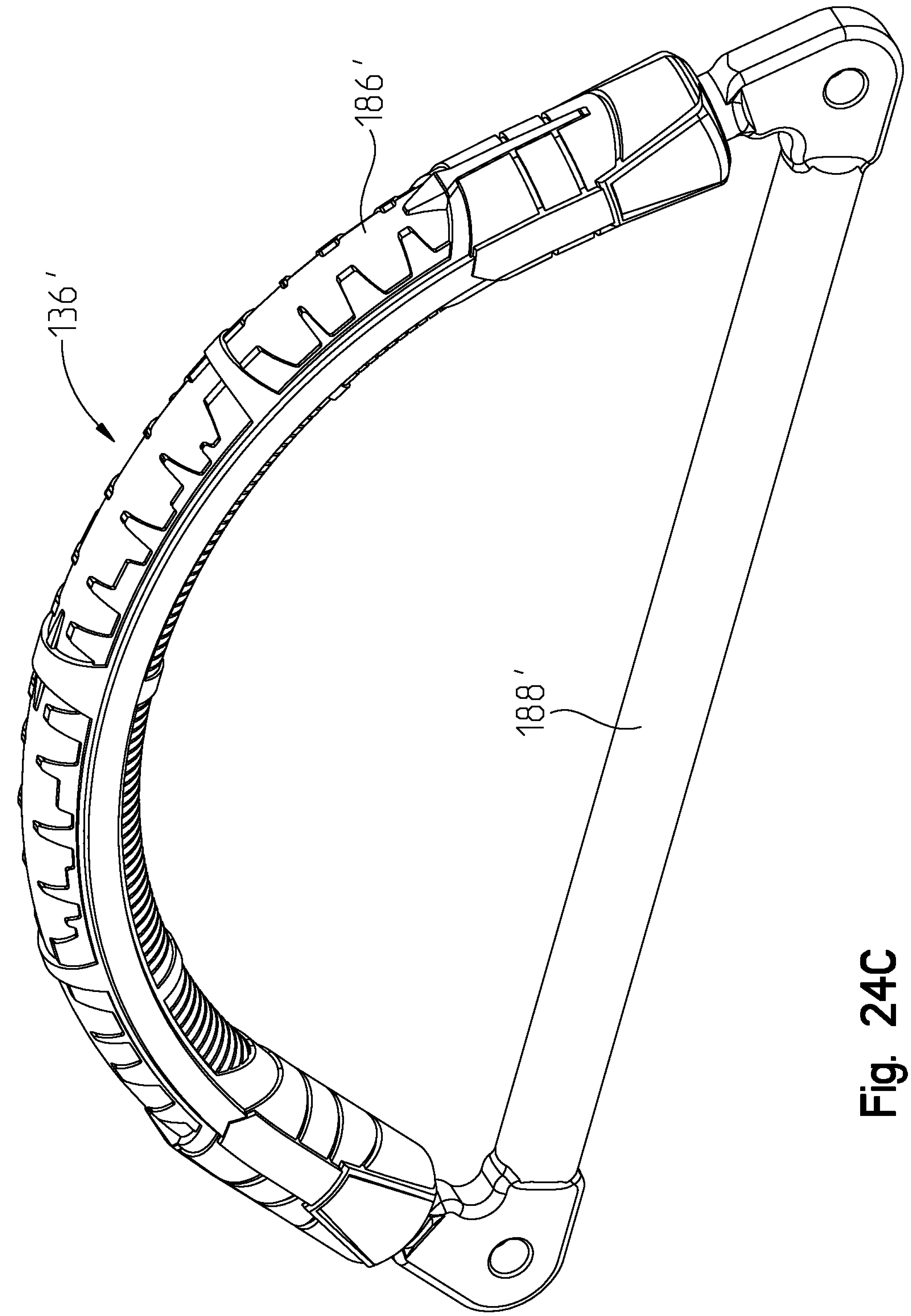
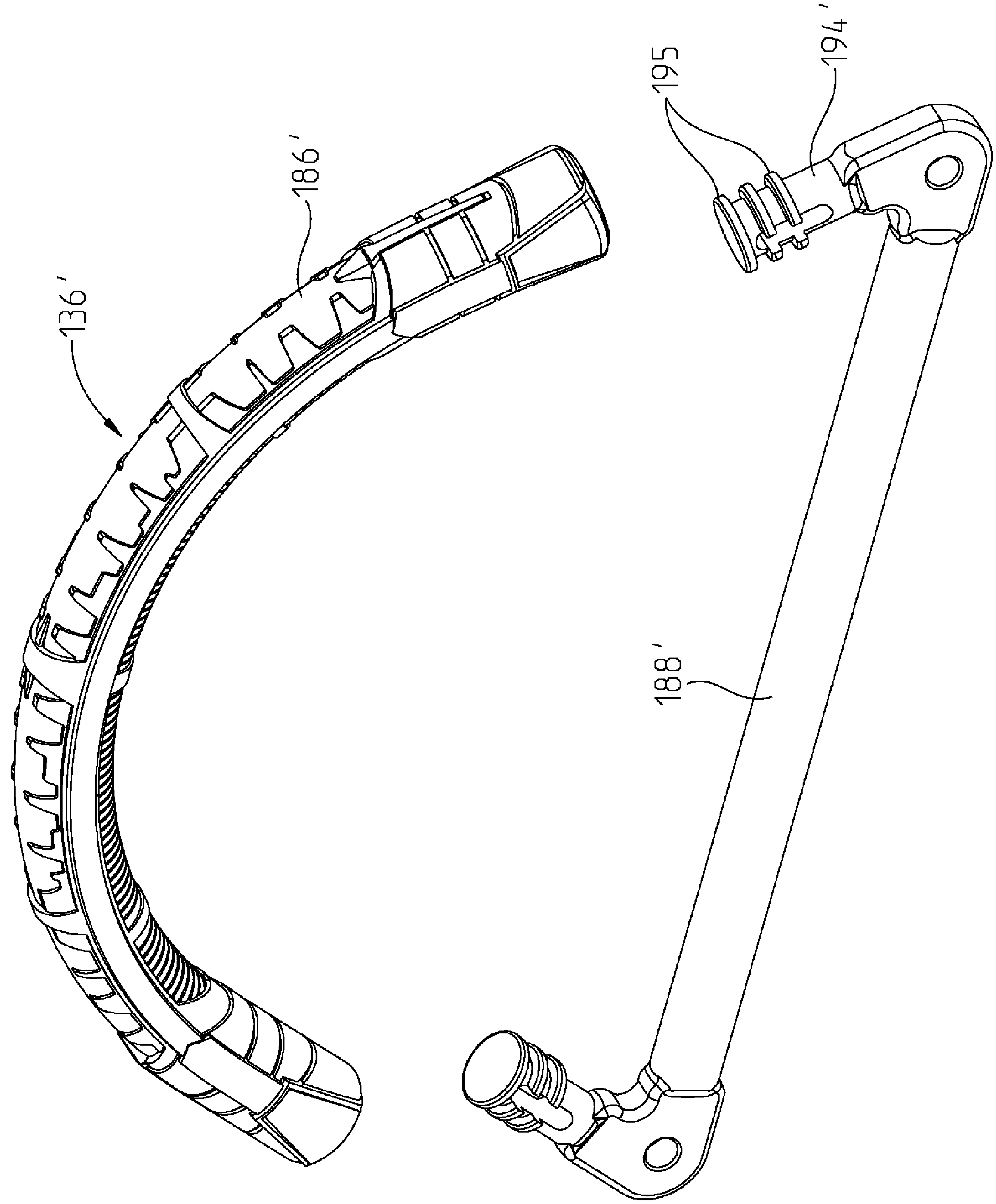


Fig. 24C



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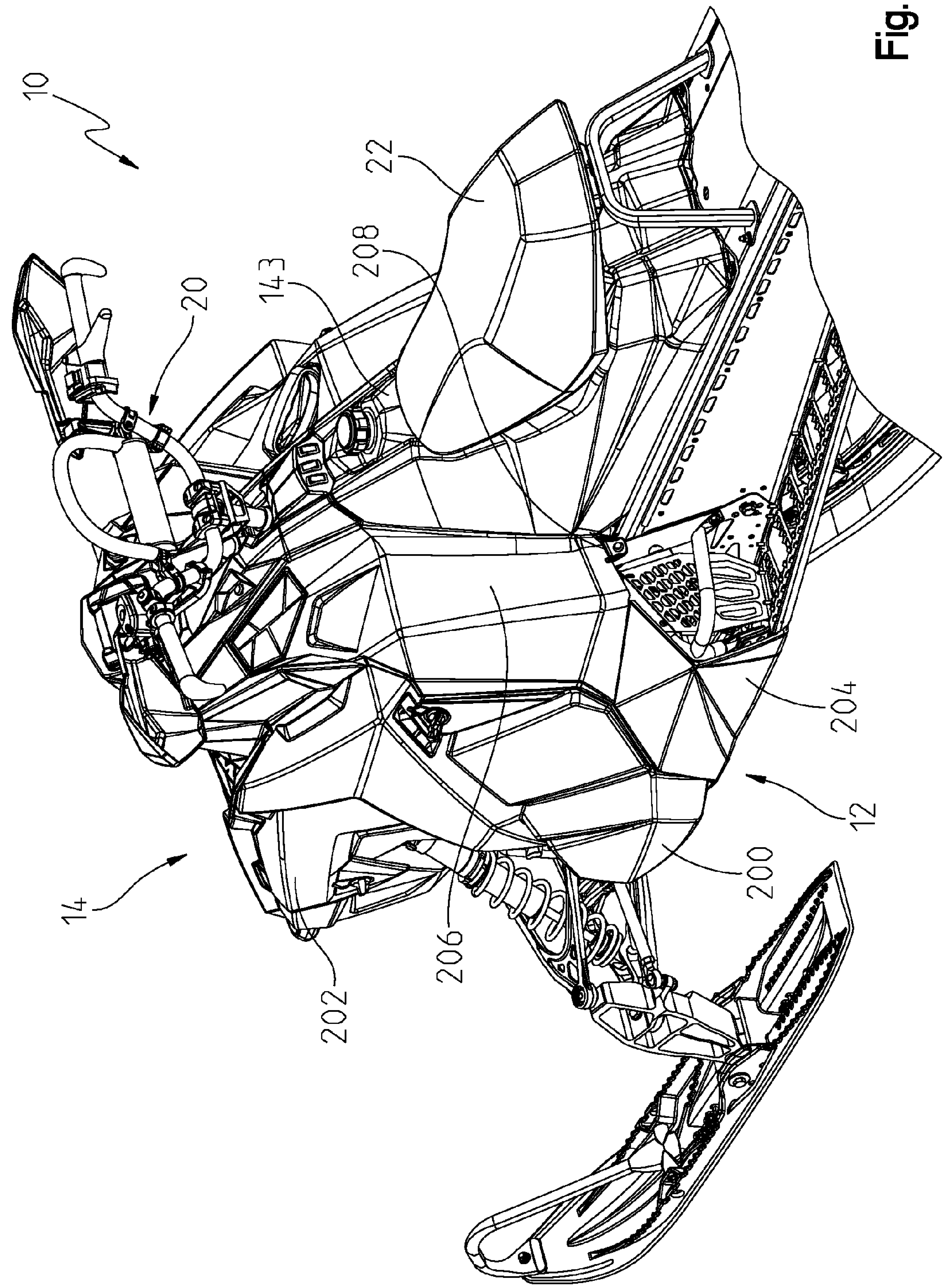


Fig. 25

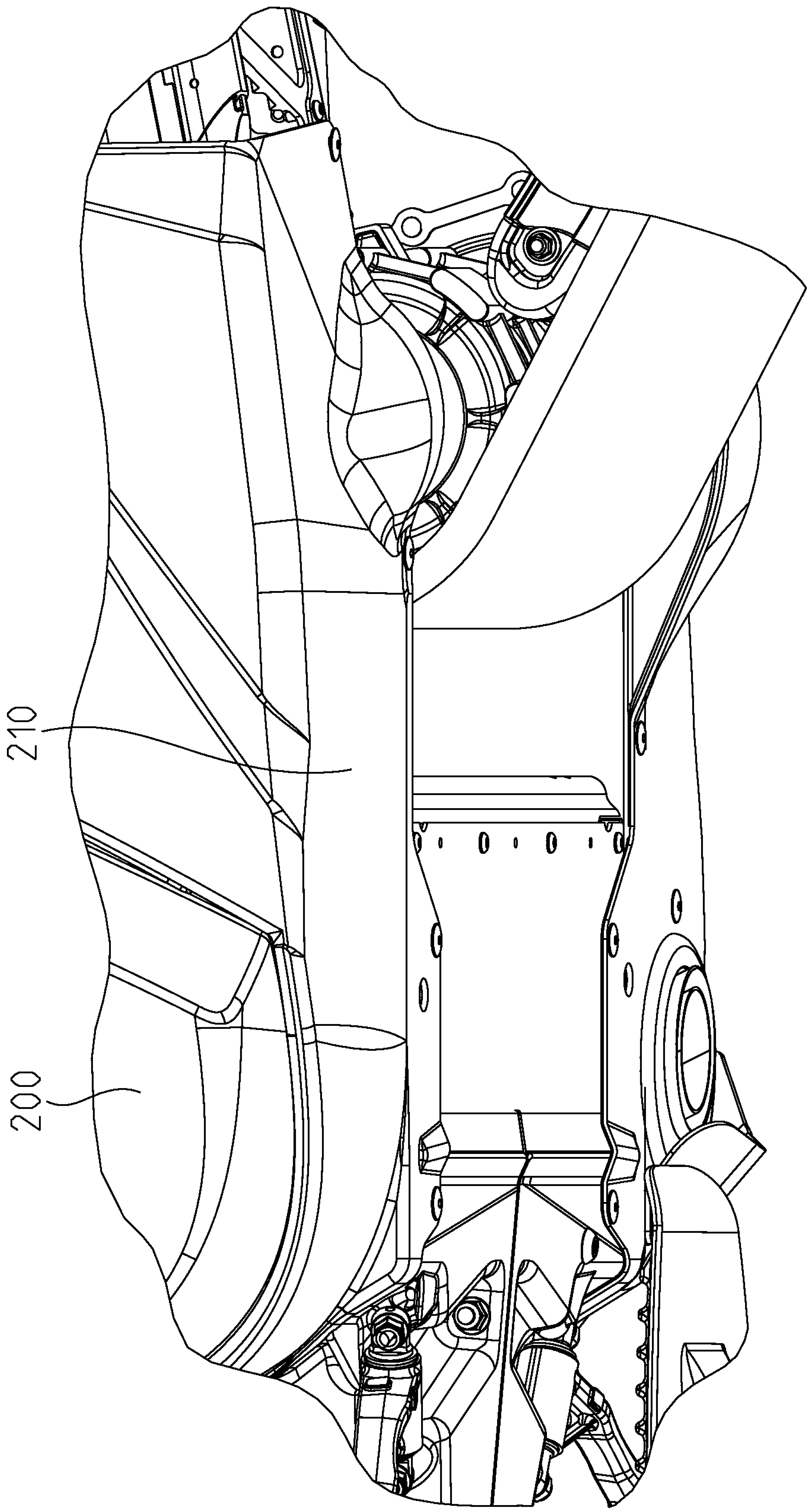
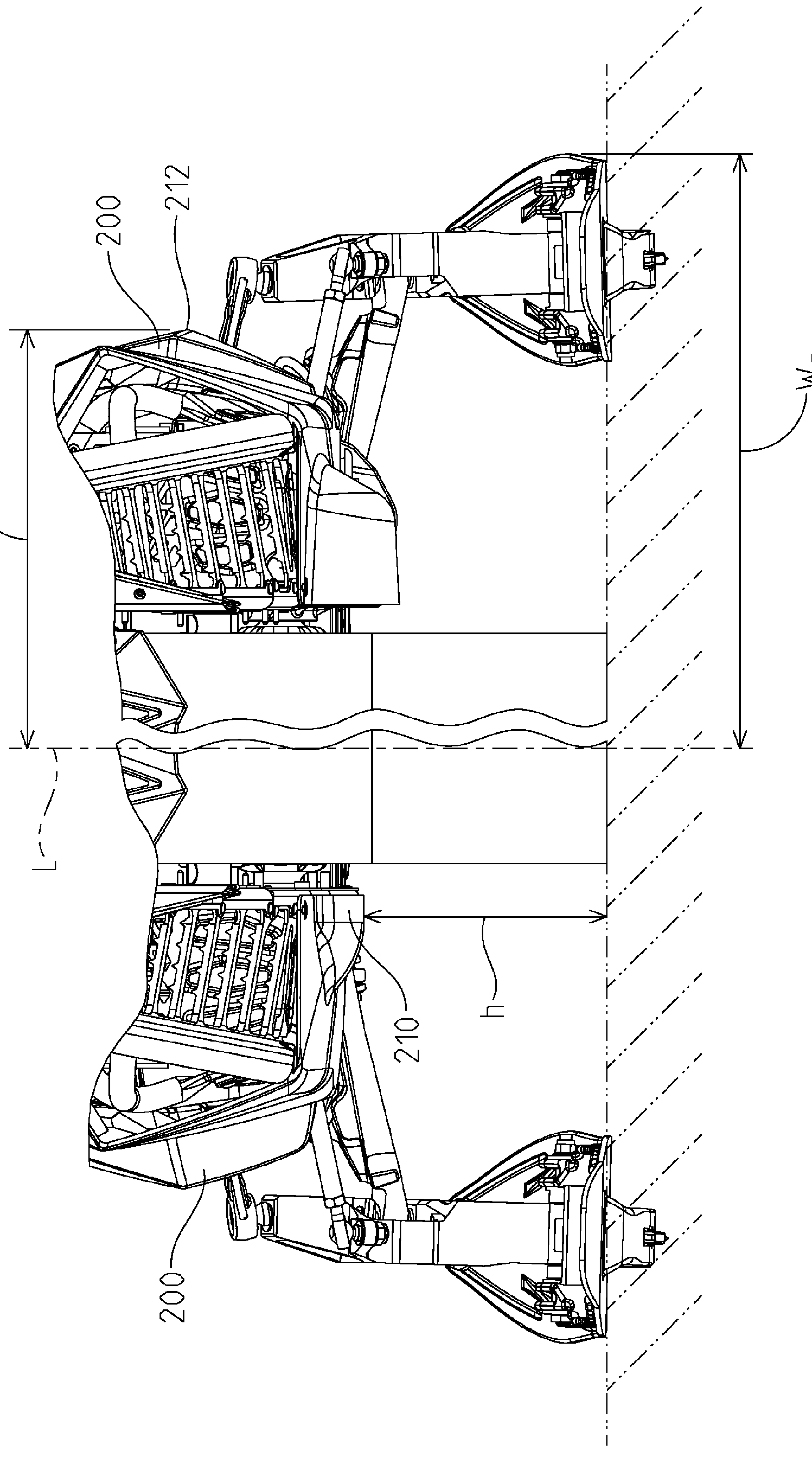


Fig. 26



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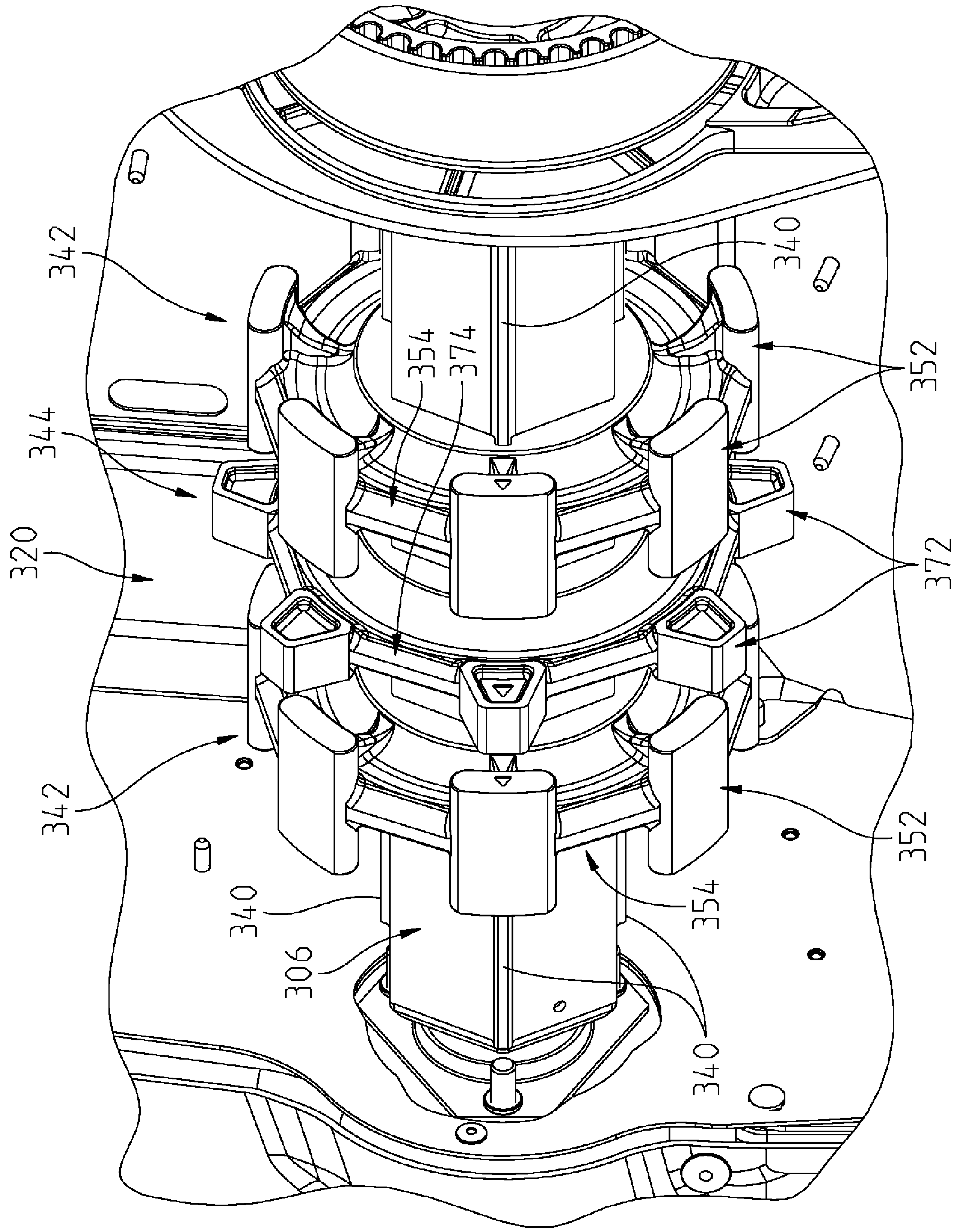

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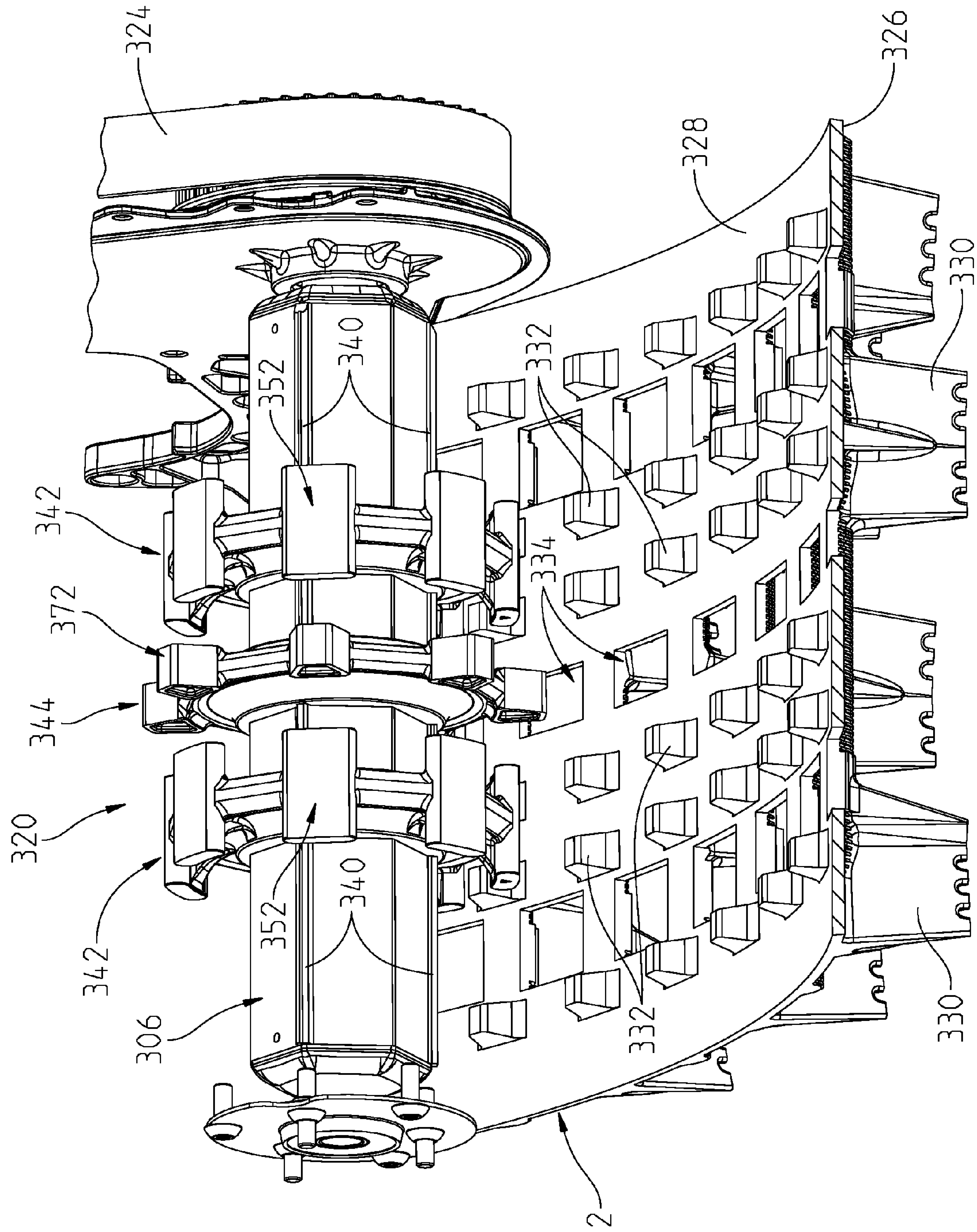

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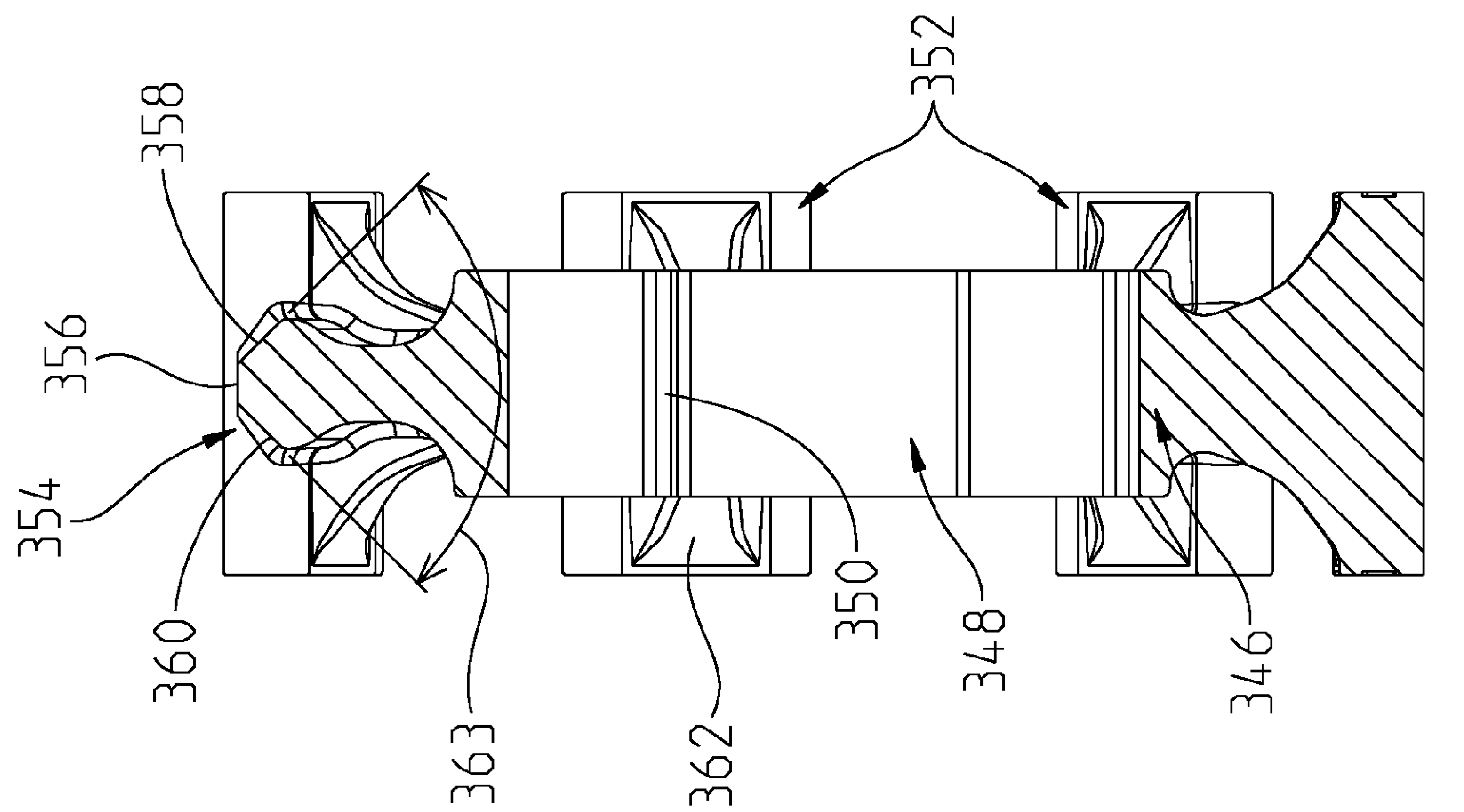
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Fig. 31

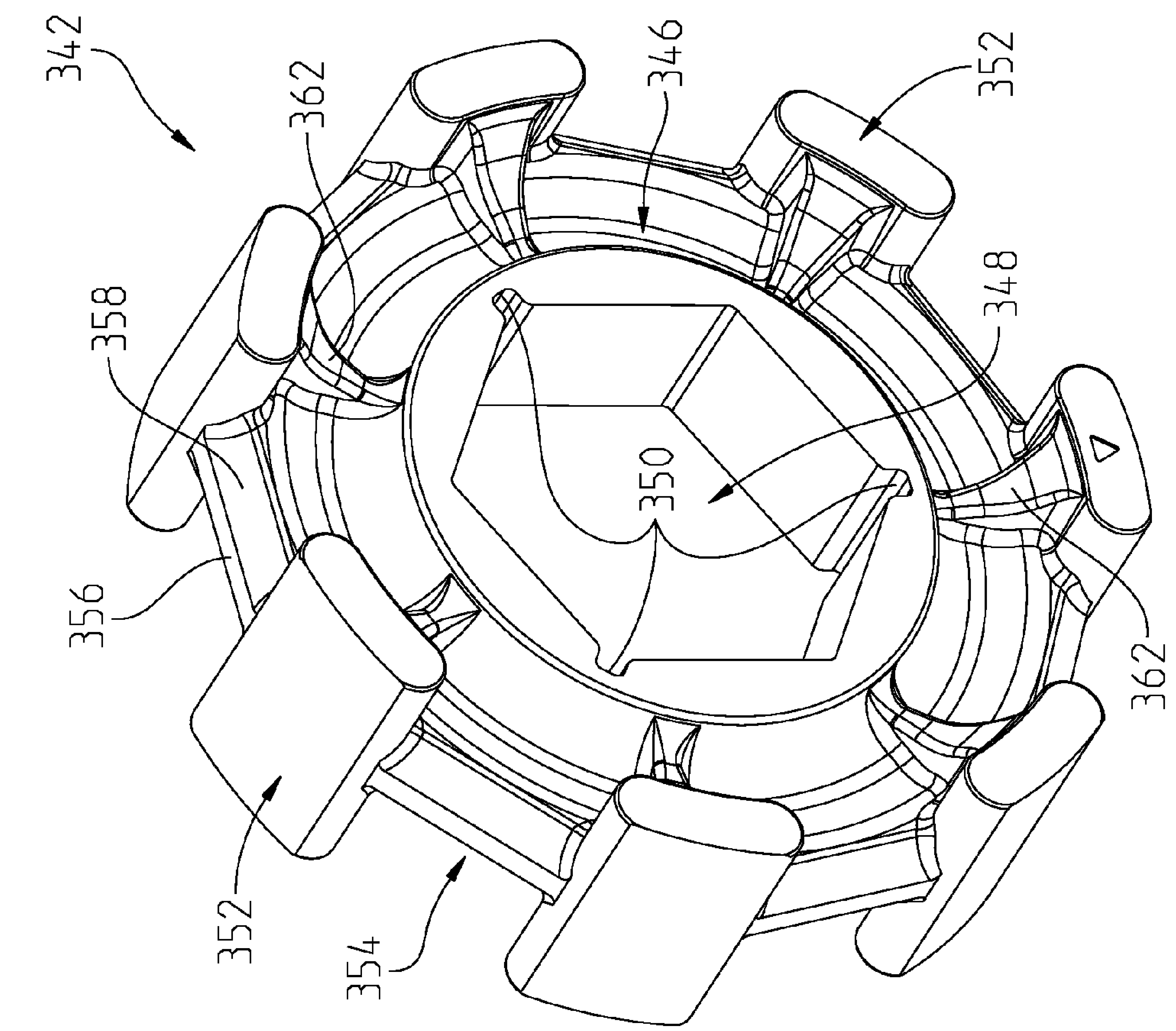
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Fig. 30

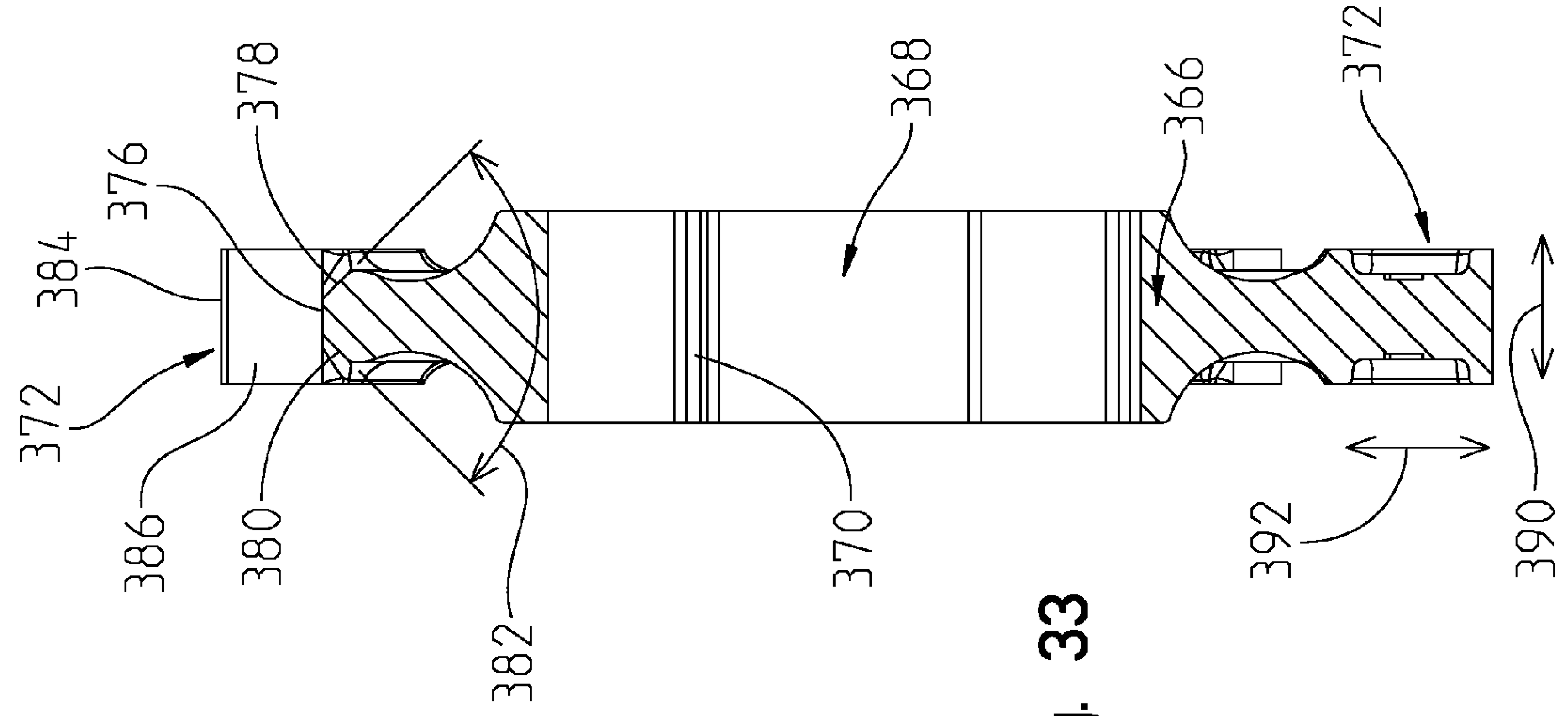
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Fig. 33

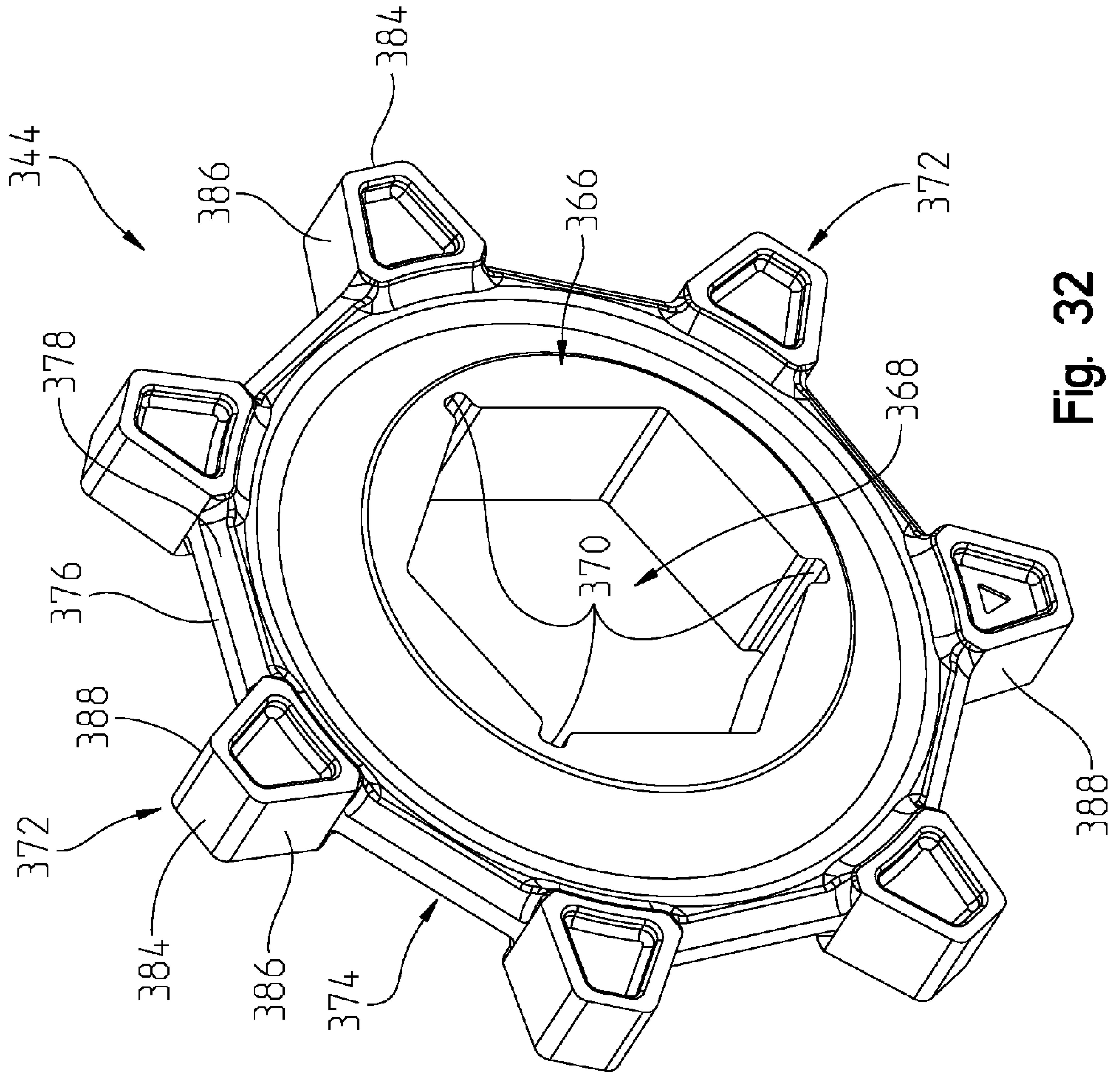
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Fig. 32

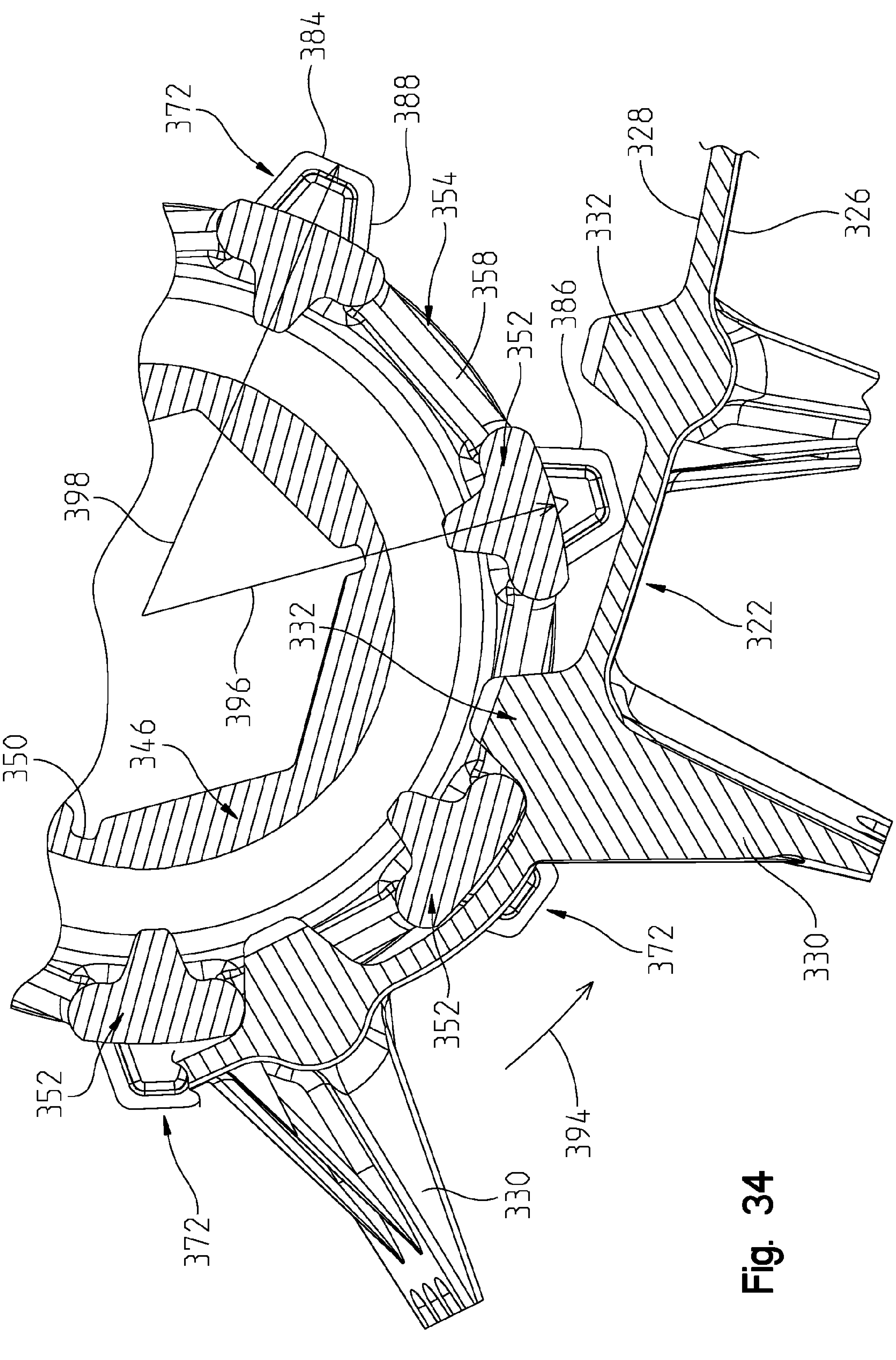
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Fig. 34

SNOWMOBILE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is related to U.S. patent application Ser. No. 13/763,282, filed on Feb. 8, 2013; U.S. patent application Ser. No. 14/151,983, filed on Jan. 10, 2014; U.S. patent application Ser. No. 14/152,596, filed on Jan. 10, 2014; U.S. patent application Ser. No. 13/563,962, filed on Aug. 1, 2012; U.S. Provisional Patent Application Ser. No. 61/513,949, filed on Aug. 1, 2011; and U.S. Provisional Patent Application Ser. No. 61/582,426, filed on Jan. 2, 2012, the complete disclosures of which are expressly incorporated by reference herein.

BACKGROUND

The present application relates to a snowmobile, and more particularly, to a lightweight snowmobile for mountains and trails.

Performance characteristics of snowmobiles depend on several parameters of the vehicle, such as width, snow clearance, suspension performance, and weight. It is known that snowmobiles travel through a variety of conditions, including deep snow, light powder, trails, and mountains. Over some terrain, the rider leans on the snowmobile for proper riding in various conditions. Various parameters of the snowmobile affect the ability of the snowmobile to lean and the comfort of the rider when doing so.

SUMMARY

In one embodiment, a snowmobile comprises a plurality of ground engaging members, a frame supported by the ground engaging members, and a powertrain assembly supported by the frame. The snowmobile further comprises a rear suspension assembly supported by the frame which includes a plurality of slide rails, at least one linear force element operably coupled to the slide rails, and at least one rear idler wheel operably coupled to the slide rails with a rear shaft. The rear shaft is operably coupled to the slide rails with a single fastener received into one end of the rear shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a left front perspective view of a snowmobile of the present embodiment;

FIG. **2** is a right rear view of the snowmobile of FIG. **1**;

FIG. **3** is a left side view of the snowmobile of FIG. **1**;

FIG. **4** is a right side view of the snowmobile of FIG. **1**;

FIG. **5** is a top view of the snowmobile of FIG. **1**;

FIG. **6** is a front view of the snowmobile of FIG. **1**;

FIG. **7** is a rear view of the snowmobile of FIG. **1**;

FIG. **8** is a left front perspective view of a rear suspension assembly of the snowmobile of FIG. **1**;

FIG. **9** is a detailed left front perspective view of rear idler wheels of the rear suspension assembly of FIG. **8**;

FIG. **10** is a cross-sectional view of the rear idler wheels of FIG. **9**;

FIG. **11** is a left front perspective view of carrier wheels of the rear suspension assembly of FIG. **8** coupled to the frame;

FIG. **12** is a left front perspective view of the carrier wheels of FIG. **11** coupled to suspension pads;

FIG. **13** is an exploded view of the suspension pad of FIG. **12**;

FIG. **14** is a left front perspective of a front suspension assembly of the snowmobile of FIG. **1**;

FIG. **15** is a left front perspective view of a portion of the front suspension assembly of FIG. **11**;

FIG. **16** is a left front perspective view of an upper control arm and a lower control arm of the front suspension assembly of FIG. **11**;

FIG. **17** is an exploded view of a bushing assembly for coupling the upper and lower control arms of FIG. **16** to the frame of the snowmobile;

FIG. **18** is a detailed exploded view of a portion of a front ski and a front spindle of the vehicle of FIG. **1**;

FIG. **19** is a left front perspective view of a steering assembly and a coupling member of the frame of the snowmobile of FIG. **1**;

FIG. **20** is a front exploded view of the coupling member of FIG. **19** and a plurality of frame members;

FIG. **21** is a rear exploded view of the coupling member and the frame members of FIG. **20**;

FIG. **22** is an exploded view of a portion of the steering assembly and the coupling member of FIG. **19**;

FIG. **23**A is a front view of a handlebar assembly of the steering assembly of FIG. **19**;

FIG. **23**B is an exploded view of the handlebar assembly of FIG. **23**A;

FIG. **24**A is a front perspective view of an alternative embodiment of the steering assembly and illustrates handlebars and a hoop assembly;

FIG. **24**B is an exploded view of the handlebars and hoop assembly of FIG. **24**A;

FIG. **24**C is a front perspective view of the hoop assembly of FIG. **24**B;

FIG. **24**D is an exploded view of the hoop assembly of FIG. **24**C;

FIG. **25** is a left rear perspective view of a body assembly of the snowmobile of FIG. **1**;

FIG. **26** is a perspective view of an underside portion of a fender of the body assembly of FIG. **25**;

FIG. **27** is a rear view of a front end of the snowmobile of FIG. **1**;

FIG. **28** illustrates a drive shaft and drive sprocket assembly of an illustrated embodiment of the present disclosure;

FIG. **29** illustrates the drive shaft and drive sprocket assembly of FIG. **28** driving a track of a snowmobile;

FIG. **30** is a perspective view of an outer drive member of the drive sprocket of FIGS. **28** and **29**;

FIG. **31** is a sectional view taken through the outer drive member of FIG. **30**;

FIG. **32** is a perspective view of a center drive member of the drive sprocket of FIGS. **28** and **29**;

FIG. **33** is a sectional view taken through the center drive member of FIG. **32**; and

FIG. **34** is a sectional view illustrating engagement of the outer drive members of the drive sprocket with drive lugs of the track of the snowmobile and illustrating teeth of the center drive member extending through windows formed in the track.

Corresponding reference characters indicate corresponding parts throughout the several views. Although the drawings represent embodiments of various features and components according to the present disclosure, the drawings are not necessarily to scale and certain features may be exaggerated in order to better illustrate and explain the present disclosure. The exemplifications set out herein illustrate embodiments of the invention, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE DRAWINGS

For the purposes of promoting an understanding of the principals of the invention, reference will now be made to the embodiments illustrated in the drawings, which are described below. The embodiments disclosed below are not intended to be exhaustive or limit the invention to the precise form disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. It will be understood that no limitation of the scope of the invention is thereby intended. The invention includes any alterations and further modifications in the illustrative devices and described methods and further applications of the principles of the invention which would normally occur to one skilled in the art to which the invention relates.

Referring to FIGS. **1-7**, an illustrative embodiment of a snowmobile **10** with a longitudinal axis L includes a chassis or frame **12** having a front frame portion **12***a* and a rear frame portion **12***b*. A body assembly **14** generally surrounds at least front frame portion **12***a* of frame **12**. Front frame portion **12***a* is supported by front ground-engaging members, illustratively skis **16**, and rear frame portion **12***b* is supported by a rear ground-engaging member, illustratively an endless track **18**. The rider uses a steering assembly **20**, which is operably coupled to at least skis **16**, when operating snowmobile **10**. A seat assembly **22** is provided generally rearward of steering assembly **20** and is configured to support the rider.

Front skis **16** are operably coupled to a front suspension assembly **24**, and endless track **18** cooperates with a rear suspension assembly **26**. A powertrain assembly is positioned generally intermediate front suspension assembly **24** and rear suspension assembly **26**, and provides power to endless track **18** to move snowmobile **10**. More particularly, the powertrain assembly **30** includes an engine, a transmission, and a drive shaft **306** (FIG. **28**). In one embodiment, the transmission is a continuously variable transmission ("CVT"). Additional details of frame **12**, body assembly **14**, endless track **18**, front suspension assembly **24**, rear suspension assembly **26**, and the powertrain assembly are disclosed in U.S. Patent Application Ser. No. 13/763,282, filed on Feb. 8, 2013, U.S. patent application Ser. No. 14/151,983, filed on Jan. 10, 2014, U.S. patent application Ser. No. 14/152,596, filed on Jan. 10, 2014, U.S. Provisional Patent Application Ser. No. 61/513,949, filed on Aug. 1, 2011, and U.S. Provisional Patent Application Ser. No. 61/582,426, filed on Jan. 2, 2012, the complete disclosures of which are expressly incorporated by reference herein.

As shown in FIG. **8**, rear suspension assembly **26** is supported by frame **12** and includes a plurality of slide rails **32**, a first linear force element ("LFE") **34**, illustratively a shock absorber, a plurality of torque arms **36** operably coupled to a forward, lower end of first LFE **34**, and a link assembly **38** operably coupled to a rear, upper end of first LFE **34**. In one embodiment, torque arms **36** may be comprised of forged aluminum, which may reduce the overall weight of snowmobile **10**. Additionally, rear suspension assembly **26** may include a second LFE **40** positioned forward of first LFE **34** and operably coupled to torque arms **36** and slide rails **32**.

Rear suspension assembly **26** also includes a plurality of rear idler wheels **42** rotatably coupled to the rear end of slide rails **32** and a plurality of carrier wheels **44** laterally adjacent the rear, upper end of first LFE **34**. Rear idler wheels **42** and carrier wheels **44** are configured to maintain tension in endless track **18**. Additionally, the position of rear idler

wheels **42** on slide rails **32** may be adjusted to adjust the tension in endless track **18**. As shown in FIGS. **1-4**, endless track **18** generally surrounds rear suspension assembly **26** and is supported on at least slide rails **32**, rear idler wheels **42**, and carrier wheels **44**. Rear suspension assembly **26** is configured to cooperate with endless track **18** when snowmobile **10** is operating. In particular, rear suspension assembly **26** is configured to move longitudinally and vertically during operation of snowmobile **10**, and the tension in endless track **18** is maintained throughout the movement of rear suspension assembly **26** by at least rear idler wheels **42**.

Referring to FIGS. **8-10**, rear idler wheels **42** are operably coupled to slide rails **32** with a rear shaft or axle **46**, which extends laterally between rear idler wheels **42** and slide rails **32** in a direction perpendicular to longitudinal axis L. Rear shaft **46** defines the axis of rotation for rear idler wheels **42**. Rear shaft **46** is coupled to slide rails **32** with a single fastener, illustratively a single bolt **48**. As shown in FIGS. **9** and **10**, rear shaft **46** is generally hollow and bolt **48** extends into only one end of rear shaft **46**. Additionally, an end cap or bracket **52** and a washer **50** may be coupled to bolt **48** when retaining rear shaft **46** on slide rails **32**. The opposing end of rear shaft **46** may include a flange **54** which is configured to be positioned along an outer side of one of slide rails **32** for further retaining rear shaft **46** on slide rails **32**. Flange **54** may be integrally coupled to or otherwise formed with rear shaft **46**. Illustratively, flange **54** is a positive retention member configured to positively retain rear shaft **46** on slide rails **32**. Because rear shaft **46** is generally hollow and only one bolt **48** is necessary for coupling rear shaft **46** to slide rails **32**, the weight of snowmobile **10** may be reduced.

Other embodiments of a rear suspension assembly may include two bolts for a rear shaft—one fastener for each rear idler wheel on the rear shaft—which requires loosening or removing both bolts in order to service the components of the rear suspension and/or adjust the tension of the track. However, with both bolts loosened or removed, the rear shaft may spin, thereby making it more difficult to adjust the tension in an endless track. Yet, in the embodiment of FIGS. **8-10**, with only one bolt **48**, it may be easier to adjust the tension in endless track **18** because only the one bolt **48** is loosened or removed and flange **54** positively retains rear shaft **46** on slide rails **32**.

Additionally, a plurality of isolators **56** are integrally coupled to rear shaft **46** and are adjacent the inner sides of slide rails **32**. Isolators **56** extend from the inner sides of slide rails **32** into a recess **64** of rear idler wheels **42**. Within recess **64** of rear idler wheels **42**, isolators **56** contact a washer **66**.

As shown in FIG. **10**, isolators **56** are engaged with couplers **58** to maintain the position of isolators **56**. Illustratively, couplers **58** are threaded bolts. As shown in FIG. **10**, couplers **58** extend parallel to longitudinal axis L and contact a forward surface isolators **56**. Couplers **58** are supported by brackets **60**, which are coupled to slide rails **32**, and maintained in position by a fastener **62**, illustratively a threaded nut. As such, in order to move rear shaft **46**, couplers **58** and fasteners **62** are loosened and/or removed to allow isolators **56** and rear shaft **46** to move.

Carrier wheels **44** also may assist in maintain the tension in endless track **18** during operation of snowmobile **10**. Referring to FIGS. **11-13**, each carrier wheel **44** is supported on frame **12** by a suspension pad **68**. More particularly, carrier wheels **44** are supported on side walls **70** of frame **12** and suspension pads **68** extend below side walls **70** to couple with a carrier wheel shaft **72**. Carrier wheel shaft **72** extends between carrier wheels **44** and is coupled to suspension pads **68** with a fastener **74**. Other conventional fasteners **83**, such as washers, may be used with fastener **74** to couple carrier wheel shaft **72** to suspension pads **68**. In one embodiment, fasteners **83** are riveted washers. Carrier wheel shaft **72** defines the axis of rotation for carrier wheels **44**.

As shown in FIGS. **12** and **13**, suspension pads **68** are comprised of an outer plate **76** and an inner plate **78** coupled together with conventional fasteners (e.g., screws, bolts). In one embodiment, inner and outer plates **78**, **76** are comprised of different materials. For example, outer plate **76** may be comprised of steel for lateral stiffness, and inner plate **78** may be comprised of a lightweight material, such as aluminum. Inner plate **78** may be extruded or otherwise formed through conventional process for aluminum. As such, suspension pads **68** have lateral stiffness for supporting carrier wheels **44** due to the steel outer plate **76** and are lightweight due to the aluminum inner plate **78**.

By comprising inner plate **78** of aluminum, suspension pads **68** also contribute to less build up of snow and ice during operation of snowmobile **10**. More particularly, as shown in FIG. **13**, an inner surface **79***a* of inner plate **78** faces inwardly toward carrier wheels **44** and an outer surface **79***b* of inner plate **78** faces outer plate **76**. As such, inner and outer surfaces **79***a*, **79***b* of inner plate **78** are not greatly exposed to snow and ice during operation of snowmobile **10** and, therefore, less snow and ice collect and build up on suspension pads **68**.

Referring to FIGS. **14-18**, front suspension assembly **24** is positioned longitudinally forward of rear suspension assembly **26** and includes an upper control arm **80**, a lower control arm **82**, a linear force element, such as shock absorber **84**, a spindle **86**, and a torsion bar **88**. As shown in FIG. **16**, upper control arm **80** includes a forward member **80***a* and a rearward member **80***b*, and lower control arm **82** includes a forward member **82***a* and a rearward member **82***b*. Front suspension assembly **24** is supported on front frame portion **12***a* of frame **12** and, in particular, is supported on a bulkhead **100** of frame **12**.

As shown in FIG. **14**, the upper end of shock absorber **84** is coupled to bulkhead **100** and the lower end of shock absorber **84** is coupled to lower control arm **82**. In one embodiment, the lower end of shock absorber **84** is directly coupled to a portion of lower control arm **82** with a coupler **112** (e.g., a bolt). For example, coupler **112** may be a threaded bolt that directly couples to a corresponding threaded aperture on lower control arm **82**, such that the coupling between the lower end of shock absorber **84** and lower control arm **82** does not require a nut or additional coupler threaded to coupler **112**.

Additionally, torsion bar **88** is operably coupled to lower control arm **82** through a link member **90**. In one embodiment, torsion bar **88** is a one-piece member that does not include any weldments or bonded portions. Upper and lower control arms **80**, **82**, as well as a steering arm **92**, are coupled to spindle **86**. More particularly, laterally outer ends of upper and lower control arms **80**, **82** are operably coupled to spindle **86**. Illustratively, conventional couplers, such as ball joints, couple the outer ends of upper and lower control arms **80**, **82** to spindle **86**.

As shown in FIGS. **14-17**, the inner ends of upper and lower control arms **80**, **82** include bushing assemblies **94**, **96**, respectively, for coupling with bulkhead **100**. Referring to FIG. **17**, each bushing assembly **94**, **96** includes a pin **102**, a bushing or other isolator **104**, a first washer or spacer **106**, a second washer or spacer **108**, and a snap ring **110**. Pin **102** is received within bushing **104**, and both pin **102** and bushing **104** are received into the inner ends of upper and lower control arms **80**, **82**. First and second washers **106**, **108** are positioned at opposing ends of pin **102** and bushing **104**. Snap ring **110** is positioned adjacent either first or second washer **106**, **108** and positively retains bushing assemblies **94**, **96** within the inner ends of upper and lower control arms **80**, **82**. More particularly, snap ring **110** is configured to decrease the tolerance between pin **102** and the inner ends of upper and lower control arms **80**, **82**. Additional details of bushing assemblies **94**, **96** are disclosed in U.S. patent application Ser. No. 13/763,282, filed on Feb. 8, 2013, U.S. patent application Ser. No. 14/151,983, filed on Jan. 10, 2014, U.S. patent application Ser. No. 14/152,596, filed on Jan. 10, 2014, U.S. Provisional Patent Application Ser. No. 61/513,949, filed on Aug. 1, 2011, and U.S. Provisional Patent Application Ser. No. 61/582,426, filed on Jan. 2, 2012, the complete disclosures of which are expressly incorporated by reference herein.

Referring to FIGS. **14-16**, at least lower control arm **82** is formed through forging. More particularly, illustrative lower control arm **82** is comprised of forged aluminum. Alternatively, in other embodiments of front suspension assembly **24**, both upper and lower control arms **80**, **82** are comprised of forged aluminum. By using aluminum for upper and lower control arms **80**, **82**, the overall weight of snowmobile **10** may be reduced.

Additionally, by forging at least lower control arm **82**, localized areas of stress may be artificially introduced into lower control arm **82** to form a predetermined yield point or failure point of lower control arm **82**. More particularly, in general, lower control arms may have uniform stress throughout, however, the illustrative embodiment of lower control arm **82** has artificially-induced areas of higher stress at predetermined and desirable localized areas of lower control arm **82**. For example, a middle section A of rearward member **82***b* (FIG. **16**) may have an intentionally-induced higher stress concentration than the remaining portions of rearward member **82***b*, thereby predetermining that the middle section of rearward member **82***b* will buckle, bend, yield, or otherwise fail at that localized middle section A upon impact. In this way, there is control over the failure mode of front suspension assembly **24**. In other words, the arrangement of front suspension assembly **24** and front frame portion **12***a* is purposely designed to limit the effects of an impact to rearward member **82***b* of lower control arm **82**. Additionally, the intentional high-stress concentrations at the predetermined areas of lower control arm **82** (e.g., at area A) may be greater than the stress threshold of other components of snowmobile **10** such that lower control arm **82** will yield or fail before other components of snowmobile **10**.

For example, during operation of snowmobile **10**, if front suspension assembly **24** contacts an obstacle, the force from the impact is absorbed by portions of snowmobile **10** and certain portions may be damaged. For example, if frame **12** of snowmobile **10** absorbs the force of the impact with the obstacle, frame **12** may be damaged, which may lead to a complete loss of snowmobile **10**, depending on the extent of the damage. However, by introducing predetermined failure points into lower control arm **82**, lower control arm **82** may yield in response to the impact to absorb the energy of the impact before other components of snowmobile **10** are affected by the impact.

Additionally, in one embodiment, upper control arm **80** is comprised of forged aluminum and, therefore, has an increased stiffness which redirects the load from an impact into lower control arm **82**, rather than frame **12**. In this way, upper control arm **80** and frame **12** may be generally unaffected by an impact because lower control arm **82** yielded in response to the impact to absorb the energy of the impact. In other words, the predetermined failure mode causes failure from an impact to occur in at least lower control arm **82** of front suspension assembly **24** in order to prevent damage to frame **12**.

Referring to FIG. **18**, a lower end of spindle **86** is coupled to ski **16**. Ski **16** is able to pivot relative to spindle **86** in order to slide over various terrain during operation of snowmobile **10**. More particularly, spindle **86** is pivotably coupled to ski **16** with a fastener **114**, illustratively a bolt, which defines a pivot axis for ski **16**. Other fasteners or couplers, such as washers **116** and nut **118**, also may be coupled to fastener **114** to secure spindle **86** to ski **16**. Additionally, a bracket **120** may be coupled to ski **16** and spindle **86** to facilitate pivoting of ski **16** relative to spindle **86**.

Even though ski **16** is configured to pivot relative to spindle **86**, ski **16** is not configured to pivot 90° relative to the ground. As such, ski **16** is not configured to "stand up" or be vertically positioned relative to the ground. In this way, the tip of ski **16** will not become vertically lodged or stuck in the snow. In order to reduce the likelihood that ski **16** will become vertically stuck in the snow, the lower end of spindle **86** includes a flange **122** which is configured to contact a rib **124** of ski **16** if ski **16** pivots in the vertical direction by a specific amount. As such, flange **122** of spindle **86** and rib **124** of ski **16** inhibit 90° rotation of ski **16** relative to spindle **86**, thereby reducing the likelihood that ski **16** will become vertically stuck in the snow.

Referring to FIGS. **19-24**D, steering assembly **20** is operably coupled to front suspension assembly **24** through steering arms **92** (FIG. **14**). Steering assembly **20** includes steering arms **92**, a steering post **132**, handlebars **134**, and a hoop assembly **136**. Steering assembly **20** is supported at front frame portion **12***a* of frame **12** and, more particularly, is supported by a coupling member **138** of frame **12**.

Illustratively, coupling member **138** includes an upper member **140** and a lower member **142**, both of which may be cast components. Upper and lower members **140**, **142** are separate components from each other and, as such, contribute to an overall weight reduction for snowmobile **10** because there is no webbing or connection extending therebetween. Additionally, by providing coupling member **138** in two separate components, the overall rigidity of coupling member **138** and steering assembly **20** may increase. Therefore, snowmobile **10** may have less flex and be more responsive to the rider.

Upper and lower members **140**, **142** are both configured to support a portion of steering post **132** and portions of frame **12**. Additionally, at least lower member **142** includes a tab **145** (FIG. **21**) for supporting a fuel tank **143** (FIG. **25**), and at least upper member **140** includes a plurality of apertures **141** which are configured as routing channels for other components of snowmobile **10**, such as brake lines and/or other fluid lines. For example, by routing components, such as brake lines, through apertures **141**, lateral movement of such lines and components may be removed. Additionally, the overall packaging and arrangement of the components of snowmobile **10** is more compact when components such as the brake lines are routed through apertures **141** and when large components, such as fuel tank **143**, are directly coupled to coupling member **138**.

In the illustrative embodiment of FIGS. **19-22**, upper member **140** includes channels **144** for supporting frame members **146** of frame **12** and cylindrical openings **148** for supporting frame members **150** of frame **12**. As shown in FIG. **20**, the upper ends of frame members **146** include support rods **152** positioned therein to reinforce the upper ends when coupled to channels **144** of upper member **140**. Support rods **152** are coupled within frame members **146** with a plurality of fasteners **154** and brackets **156**. As shown, fasteners **154** extend through apertures in frame members **146**, brackets **156**, support rods **152**, and channels **144** of upper member **140** in order to couple frame members **146** to upper member **140** of coupling member **138**.

Upper member **140** also supports frame members **150** of frame **12** within cylindrical openings **148**. As shown in FIG. **21**, the upper ends of frame members **150** are received within cylindrical openings **148** and retained therein with fasteners **160**. Frame members **150** are further supported by lower member **142** of coupling member **138**. More particularly, lower member **142** includes cylindrical openings **162** for receiving frame members **150**. Fasteners **164** extend through apertures in lower member **142** and frame members **150** in order to retain frame members **150** on lower member **142**. Illustratively, when coupled to coupling member **138**, frame members **146**, **150** are angled, or extend diagonally downward, from upper and lower members **140**, **142**.

Referring to FIG. **22**, upper and lower members **140**, **142** also include an upper web **158** and a lower web **168**, respectively, for supporting steering post **132**. More particularly, an upper end of steering post **132** is coupled to upper web **158** with an upper bracket assembly **170**. Upper bracket assembly **170** includes a first bracket member **170***a* and a second bracket member **170***b* which are coupled to upper web **158** with fasteners **172** and generally surround a portion of steering post **132**. Similarly, a lower end of steering post **132** is coupled to lower web **168** with a lower bracket assembly **174**. Lower bracket assembly **174** includes a first bracket member **174***a* and a second bracket member **174***b* which are coupled to lower web **168** with fasteners **176** and generally surround a portion of steering post **132**.

As shown in FIG. **22**, steering post **132** is generally intermediate upper member **140** and lower member **142** of coupling member **138**. In this way, steering post **132** is positioned rearward of the upper ends of frame members **146**, **150**, and is forward of cylindrical openings **162** of lower member **142** of coupling member **138**. Additionally, because frame members **146**, **150** extend diagonally downwards from upper and lower members **140**, **142** of coupling member **138**, the upper end of steering post **132** is positioned rearward of the upper ends of frame members **146**, **150** while the lower end of steering post **132** is positioned rearward of the upper ends of frame members **146** but is generally vertically aligned with the upper ends of frame members **150**. In other words, a vertical plane extending through a centerline of steering post **132** would intersect the upper ends of frame members **150** at the lower of steering post **132** but would not intersect the upper ends of frame members **146**.

Referring to FIGS. **23**A and **23**B, hoop assembly **136** of steering assembly **20** is coupled to handlebars **134**. Handlebars **134** include a lower portion **178**, a generally vertical portion **180**, and a generally horizontal portion **182**. As shown in FIG. **23**A, steering post **132** is operably coupled to lower portion **178** of handlebars **134** such that movement of handlebars **134** rotates steering post **132** to steer snowmobile **10**.

Hoop assembly **136** includes a hoop member **186** and a cross bar **188** which are coupled to generally vertical portions **180** of handlebars **134** with bracket assemblies **184**. In this way, hoop assembly **136** is integrated into handlebars

134. As shown in FIGS. **23**A and **23**B, hoop member **186** generally defines an upside-down "U" shape and is coupled to cross bar **188**. Cross bar **188** may be surrounded by a padding **190**. As shown, cross bar **188** is positioned vertically intermediate lower portion **178** and horizontal portion **182** of handlebars **134**, such that cross bar **188** extends horizontally between generally vertical portion **180**.

In one embodiment, hoop member **186** includes pegs **194** which are received within openings **192** of cross bar **188** in order to couple cross bar **188** to hoop member **186**. Fasteners **196**, such as nuts, spacers, washers, or any other conventional coupler, retain hoop member **186** on cross bar **188**. Additionally, in order to retain hoop assembly **136** on handlebars **134**, fasteners **199** extend through openings **185** on bracket assemblies **184** and openings **198** on cross bar **188**. More particularly, bracket assembly **184** generally wraps around, or surrounds a portion of, generally vertical portion **180** of handlebars **134** and is coupled to cross bar **188** with fasteners **199**.

Referring to FIGS. **24**A-D, an alternative embodiment hoop assembly **136'** is shown. Hoop assembly **136'** includes a hoop member **186'** and a cross bar **188'** which are coupled to generally vertical portions **180** of handlebars **134** with bracket assemblies **184**. Hoop member **186'** generally defines a semi-circle and may be comprised of a polymeric material, such as polyurethane).

Hoop member **186'** is coupled to cross bar **188'** with pegs **194'**. More particularly, pegs **194'** may be integrally formed with cross bar **188'**, and as such, both pegs **194'** and cross bar **188'** may be comprised of aluminum. In this way, cross bar **188'** and pegs **194'** define a one-piece or integral component of hoop assembly **136'**. Pegs **194'** include retention features, such as ridges **195**, which are received within the ends of hoop member **186'** and mechanically couple together hoop member **186'** and cross bar **188'**. Additionally, hoop member **186'** is overmolded onto pegs **194'**, thereby defining an integral hoop assembly **136'**. As such, hoop member **186'** and cross bar **188'** are permanently coupled together through overmolding and without fasteners to define a one-piece hoop assembly **136'**.

By including hoop assemblies **136**, **136'** on snowmobile **10**, the rider may be able to more accurately control the movement of snowmobile **10**. For example, the rider is able to extend his/her hand or arm through hoop assemblies **136**, **136'** and hold onto hoop members **186**, **186'** for more effective movement of snowmobile **10**, especially when side hilling. Additionally, the rider may be able to lean forward on snowmobile **10**, thereby pressing his/her chest against hoop assemblies **136**, **136'**, for more effective movement of snowmobile **10**, for example when riding uphill, because padding **190** supports the rider's chest against hoop assemblies **136**, **136'**.

Referring to FIGS. **25**-**27**, body assembly **14** of snowmobile **10** generally surrounds frame **12**, the powertrain assembly, a portion of steering assembly **20**, and other components of snowmobile **10**. Body assembly **14** includes fenders **200**, a hood **202**, side cowlings **204**, and at least one console panel **206**. Console panel **206** is generally rearward of hood **202** and faces the rider. A distance between the lower end of steering post **132** and a rearward-most end **208** of console panel **206** is approximately 220 mm, thereby allowing the rider to be sufficiently near steering assembly **20** during operation of snowmobile **10**. As such, the configuration of console panel **206** increases the comfort and ergonomics for the rider.

Additionally, to increase the lean angle of snowmobile **10**, the width of body assembly **14** is decreased and the snow clearance of body assembly **14** is increased. For example, as shown in FIG. **27**, the height (h) between the ground and the undercarriage of snowmobile **10** is approximately 230-240 mm and, illustratively, is approximately 235 mm. In one embodiment, the height of spindles **86** is increased in order to increase the snow clearance of snowmobile **10**.

Referring to FIGS. **26** and **27**, fenders **200** include a smooth and generally flat or horizontal bottom surface **210** which faces the ground. To increase the lean angle of snowmobile **10**, the width of body assembly **14**, including the width of bottom surface **210**, is decreased. More particularly, body assembly **14** is positioned directly adjacent other components of snowmobile **10**, such as transmission **304**, in order to decrease the overall packaging of snowmobile **10**, thereby decreasing the width and inhibiting snow accumulation. For example, the width W_F from longitudinal axis L of snowmobile **10** to an outermost end **212** of fender **200** is approximately 450-470 mm and, illustratively, is approximately 460 mm. In other words, the width between the outermost ends **212** of fenders **200** is illustratively approximately 920 mm. However, the width Ws from longitudinal axis L to the outermost end of ski **16** is approximately 580-600 mm and, illustratively, is approximately 590 mm. In other words, the width between the outermost ends of skis **16** is illustratively approximately 1180 mm. As such, the total width of body assembly **14** is less than that total width of skis **16**. Illustratively, outermost end **212** of fender **200** is positioned inwardly from the outer end of skis **16** and is positioned inwardly of spindles **86**. In other words, the outer ends of skis **16** are positioned laterally outward from outermost ends **212** of fender **200**. In this way, body assembly **14** does not interfere with the rider's ability to lean snowmobile **10**, and the lean angle of snowmobile **10** increases.

Additionally, the ratio of the width of ski **16** relative to the width of bottom surface **210** of fender **200** is approximately 1.1, which also improves the lean angle of snowmobile **10**. More particularly, the width of ski **16** is approximately 180-185 mm and, illustratively, is approximately 182 mm, while the width of bottom surface **210** of fender **200** is approximately 165-175 mm and, illustratively, is approximately 169 mm. As such, bottom surface **210** of fender **200** does not decrease the lean angle of snowmobile **10**. Additionally, by decreasing the width of body assembly **14**, a variety of positions for the rider may be available on snowmobile **10**.

Details of a drive assembly for a track of the snowmobile are best shown in FIGS. **28**-**34**. Drive assembly includes a drive shaft **306** and a drive sprocket assembly **320** mounted on the drive shaft **306**. The drive sprocket assembly **320** is configured to drive an endless belt or track **322** as the drive sprocket assembly **320** is rotated by a drive belt **324** coupled to drive shaft **306**.

The endless track **322** includes an outer surface **326** and an inner surface **328**. A plurality of tread lugs **330** extend outwardly from outer surface **326**. A plurality of drive lugs **332** extend inwardly from inner surface **328** of track **322**. Track **322** is also formed to include a plurality of openings or windows **334**.

Additional details of the drive shaft **306** and drive sprocket assembly **320** are illustrated in U.S. patent application Ser. No. 13/563,962, filed on Aug. 1, 2012, owned by the assignee of the present application, the disclosure of which is expressly incorporated by reference herein. Drive shaft **306** has a hexagonal shape and includes three outwardly extending ribs **340**. Drive sprocket assembly **320** includes a pair of outer drive members **342** and a center drive member **344** located between the outer drive members **342**.

Outer drive members **342** are best illustrated in FIGS. **30** and **31**. Outer drive members **342** include a body portion **346** having a hexagonal shaped center opening **348** and three grooves **350** aligned with ribs **340** of drive shaft **306**. Outer drive members **342** also include a plurality of teeth **352** which extend generally parallel to a longitudinal axis of the drive shaft **306**. A connecting web **354** extends between each of the teeth **352**. In an illustrated embodiment, the connecting web **354** includes a top surface **356** and side angled surfaces **358** and **360**. The angled surfaces **358** and **360** are aligned an angle of less than 180° relative to each other as illustrated by angle **363** in FIG. **31**. Preferably, the angle **363** is 90° or less. It is understood that other embodiments may not include the top flat portion **356** of the web **354** so that angled side surfaces **358** and **360** meet at a point or curved surface. The angled side surfaces **358** and **360** minimize snow build up on the outer drive members compared to flat connecting web designs. Ramped surfaces **362** also extend from body portion **346** of outer drive members **342** to the teeth **352**. These ramped surfaces also reduce snow build up adjacent the teeth **352**.

Center drive member **344** is best illustrated in FIGS. **32** and **33**. Center drive member **344** includes a body portion **366** having a hexagonal shaped center opening **368** and three grooves **370** aligned with ribs **340** of drive shaft **306**. Center drive member **344** also includes a plurality of teeth **352** which extend radially outwardly from the body portion **366** generally transverse to the longitudinal axis of the drive shaft **306**. A connecting web **374** extends between each of the teeth **372**. In an illustrated embodiment, the connecting web **374** includes a top surface **376** and side angled surfaces **378** and **380**. The angled surfaces **378** and **380** are aligned an angle of less than 180° relative to each other as illustrated by angle **382** in FIG. **33**. Preferably, the angle **382** is 90° or less. It is understood that other embodiments of the web **374** may not include the top flat portion **376** so that angled side surfaces **378** and **380** meet at a point or curved surface. The angled side surfaces **378** and **380** of web **374** minimize snow build up on the center drive member **344** compared to flat connecting web designs.

The teeth **372** of center drive member **344** each include a top surface **384** and first and second angled side surfaces **386** and **388**. Angled side surfaces **386** and **388** are illustratively aligned at an angle of about 35° relative to each other and are configured to engage opposite edges of the track windows **334** if the teeth **352** of outer drive members **342** begin to slip on drive lugs **332** of track **322** in a forward direction or a reverse direction. Teeth **372** include a width dimension **390** and a height dimension **392** as best shown in FIG. **33**. The width dimension **390** and height dimension **392** are selected to control ratcheting of the drive sprocket assembly **320** in the track **322** during operation as discussed below.

FIG. **34** illustrates operation of the drive sprocket assembly **320** to propel the endless track **322** upon rotation of the drive shaft **306**. Drive shaft is rotated to rotate drive sprocket assembly **320** in the direction of arrow **394** to move the endless track **322**. The teeth **352** of outer drive members **342** engage drive lugs **332** on inner surface **328** to move the track **320**. The teeth **372** of center drive member **344** enter the windows **334** of track **322**. The side portions **386** and **388** of teeth **372** are configured to engage edges of track **328** defining the windows **334** if the teeth **352** of outer drive member **342** begin to slip over lugs **332** of track **322**.

The radius of the outer drive members **342** taken to an outer surface of teeth **352** is illustrated by dimension **396** in FIG. **34**. The radius of the center drive member **344** taken to outer surface **384** of teeth **372** is illustrated by dimension **398** in FIG. **34**. In an illustrated embodiment, the radii **396** and **398** are selected to control slippage or ratcheting during operation, but to permit ratcheting of the drive sprocket **320** relative to the track **322** when an exerted force exceeds a predetermined level to reduce the likely of damage to upstream drive components. In illustrated embodiments, the radius **398** of the center drive member **344** is 15% to 23% larger than the radii **396** of the outer drive members **342** to optimize ratcheting control for the drive sprocket assembly **320**.

While this invention has been described as having an exemplary design, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practices in the art to which this invention pertains.

What is claimed is:

1. A snowmobile, comprising:

a plurality of ground engaging members;

a frame supported by the ground engaging members;

a powertrain assembly supported by the frame; and

a rear suspension assembly supported by the frame and including:

- a plurality of slide rails;
- at least one linear force element operably coupled to the slide rails; and
- at least one rear idler wheel operably coupled to the slide rails with a rear shaft;

the rear shaft having a first end operably coupled to a first of the slide rails with a single fastener and a second end operably coupled to a second of the slide rails by a radially-extending flange of the rear shaft integral with an outer surface of the rear shaft, the radially-extending flange being laterally outward of the second slide rail and defining a laterally-outermost surface of the second end of the rear shaft.

2. The snowmobile of claim **1**, wherein the flange is coupled to the rear shaft and is configured to inhibit axial movement of the rear shaft relative to the slide rails when the single fastener is coupled to the first end of the rear shaft.

3. The snowmobile of claim **2**, wherein the flange abuts the other of the slide rails when the rear shaft is coupled to the slide rails.

4. The snowmobile of claim **1**, wherein the rear suspension assembly further includes at least one isolator coupled to the rear shaft and positioned adjacent an inner surface of one of the slide rails.

5. The snowmobile of claim **4**, wherein the at least one rear idler wheel includes a recess and a portion of the at least one isolator is positioned within the recess.

6. The snowmobile of claim **5**, wherein the rear suspension assembly further includes a coupler operably engaged with the at least one isolator.

7. The snowmobile of claim **6**, wherein the coupler extends longitudinally along the inner surface of the one of the slide rails.

8. The snowmobile of claim **1**, further comprising at least one isolator extending between the at least one rear idler wheel and one of the slide rails.

9. The snowmobile of claim **8**, wherein at least a portion of the at least one isolator is received within a recess of the at least one rear idler wheel.

10. The snowmobile of claim **8**, further comprising at least one coupler in contact with the at least one isolator and extending parallel to a longitudinal axis of the snowmobile, and all portions of the at least one coupler are spaced apart from the rear shaft by the isolator.

11. The snowmobile of claim **8**, wherein the at least one rear idler wheel includes a first rear idler wheel and a second rear idler wheel, and the at least one isolator includes a first isolator and a second isolator, and the first isolator extends between the first rear idler wheel and one of the slide rails, and the second isolator extends between the second rear idler wheel and another of the slide rails.

12. A snowmobile, comprising:
- a plurality of ground engaging members;
- a frame supported by the ground engaging members;
- a powertrain assembly supported by the frame; and
- a rear suspension assembly supported by the frame and including:
  - at least two slide rails;
  - at least one linear force element operably coupled to the at least two slide rails;
  - a rear shaft extending between the at least two slide rails and being coupled to the at least two slide rails by only one tension-applying fastener at only one end of the rear shaft, the one tension-applying fastener being configured to apply tension to retain the rear shaft in a fixed position between the at least two slide rails; and
  - at least one rear idler wheel operably coupled to the at least two slide rails.

13. The snowmobile of claim **12**, wherein the rear suspension assembly further includes at least one retention member coupled to the rear shaft and configured to inhibit movement of the rear shaft relative to the at least two slide rails when the one tension-applying fastener is coupled to the one end of the rear shaft.

14. The snowmobile of claim **13**, wherein the one tension-applying fastener is coupled to a first end of the rear shaft and the retention member is coupled to a second end of the rear shaft.

15. The snowmobile of claim **14**, wherein the retention member is a flange integrally coupled to the rear shaft.

16. The snowmobile of claim **12**, wherein the rear shaft has an open first end and an open second end, and the one tension-applying fastener is received within the open first end of the rear shaft to close the open first end when the rear shaft is coupled to the at least two slide rails, and the open second end remains open when the rear shaft is coupled to the at least two slide rails.

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